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UNITED STATES DEPARTMENT OF THE INTERIOR
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BUREAU OF SPORT FISHERIES AND WILDLIFE

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SUMMARY REPORT OF SURVEY TO EVALUATE THE NEED FOR SPECIFIC FISH TOXICANTS IN SPORT FISHING WATERS

John F. LesVeaux
Research and Development, Food Machinery and Chemical Corporation
Middleport, New York

THE MANIPULATION OF FISH POPULATIONS is a widely attempted but seldom fully accomplished task for conservation agencies. To assist in this difficult and complex work, it would be convenient to have specific chemicals that would be lethal to unwanted species but harmless to desirable species.

Such an objective is not so fantastic as it may sound. Virtually all organic chemicals are more or less specific; that is, when tested for toxicity to a number of species, the chemicals are seldom equally toxic to all species. Therefore, it is a matter of testing to find those chemicals which are satisfactory for the intended purpose.

To get an idea of the various fishery-management problems around the country, we sent the questionnaire shown on the following page to the States, Puerto Rico, and TVA.

The replies to this questionnaire have been tabulated. In this table, States from which no reply was received have been included as blanks.

Excerpts From Replies

A. Northeast

Maine

"Our present program involves complete removal (if possible) of all species in small ponds. These ponds are then managed for brook trout. A more effective toxicant which will insure a complete kill is desirable. Rotenone often results in incomplete kill. Toxaphene is being tested." (Robert E. Foye)

New Hampshire

"It is encouraging to hear that you are contemplating research in the development of a specific chemical. Without doubt, such a product would have considerable merit in certain instances.

"I feel, however, that there would be very little demand in New Hampshire for a new specific chemical, should the cost be three to seven times greater than a non-specific type." (Robert B. Knowlton)

Massachusetts

"Whatever the cost, our use of a specific fish toxicant would be very limited and not dependent upon cost. We feel that our most serious problems involve several species which, because of over-abundance and slow growth rates, are undesirable. We do not feel that a specific removal of one or more species would have widespread application here in Massachusetts.

"We would be more interested in a better non-specific toxicant .... Information based on well over 100 reclaimed lakes has shown us that in most cases there were not enough desirable fish present to justify an attempt to save them. This might not be true in other areas, but it should be remembered that intensive

NIAGARA CHEMICAL DIVISION

Questionnaire on the potential market for specific chemicals for the control of carp and other unwanted fish.

1. Approximately how much is spent in your State (public & private funds) per year for the control of all unwanted fish by all methods such as chemical, netting, trapping, draw-down, etc.?

_____

2. How much for chemical control of all species?

_____

3. How much for control of carp by all methods?

_____

4. What species, other than carp, do you wish to control or eliminate (in order of importance)?

_____

5. What are your three most important game species (in order of importance)?

a. _____ c. _____

b. _____

6. It seems probable that a chemical can be found that will control one species without injuring another--in short, a technically satisfactory specific--but to find one that is effective at the same cost per acre-foot compounds the difficulty of the task.

The material cost of 5% emulsifiable rotenone is about $1.05 per acre-foot. What percentage of the rough-fish control market do you think would be open to the new specific chemical if the retail cost were:

a. $3.00 per acre-foot _____

b. $5.00 per acre-foot _____

c. $7.00 per acre-foot _____

7. Remarks:

Date _____ Signed _____

management would not be undertaken if the fishing was good!" (Frank Grice)

Connecticut

"A specific toxicant effective against bluegill sunfish would be of considerable value in this State. Probably use $5 - $10,000 per year." (Cole W. Wilde)

New York

"While it would take considerable exploration and educational work, this field has, I believe, a very large future development." (J. R. Greeley)

Pennsylvania

"It is believed that a technically satisfactory specific chemical would be acceptable for at least some usage at any of the prices listed." (Arthur D. Bradford)

New Jersey

"With respect to fish populations, our New Jersey lakes are not, as a rule, so

REPLIES TO THE QUESTIONNAIRE

State	(1) Total control (thousands of dollars)	(2) Chemical control (thousands of dollars)	(3) Carp control (thousands of dollars)	(4) Trash fish	(5) Game species	(6) Specific to cost (per acre-foot) $3	$5	$7
Alabama	7	7	0	Shad, gar, sucker, bullheads, grindle, buffalo.	Bass, crappie, bluegill, largemouth bass.	65	----	----
Arizona	25	10	20	Buffalo, green sunfish, suckers.	Channel catfish, black bass, trout.	50	35	15
Arkansas	-------	--------	-------	----------	----------	----	----	----
California	30	30	12	Bullheads, squawfish.	Trout, salmon, bass, catfish, pan fish.	----	----	----
Colorado	30	20	10	Suckers, bullheads, perch, trout, bluegill, yellow perch.	Trout, largemouth bass, walleye.	80	60	30
Connecticut	20	20	.5	----------	Trout, bass, pickerel.	----	----	----
Delaware	1-5	1-5	1-5	Golden shiner, bullhead, sunfish, crappies, bluegill.	Largemouth bass, pickerel, black crappie.	100	50	25
Florida	50	35	0	Gizzard shad, gar, bowfish (mudfish).	Bream, crappie, bass.	50	50	50
Georgia	3	1.5	1.5	Suckers, gar, grinnels, catfish.	Bass, bream, crappie.	----	----	----
Idaho	10-20	10-20	10-20	Minnows, suckers, spiny-ray species.	Trout, whitefish, spiny-ray species.	50	25	5
Illinois	-------	--------	-------	----------	----------	----	----	----

REPLIES TO THE QUESTIONNAIRE--Continued.

State	(1) Total control (thousands of dollars)	(2) Chemical control (thousands of dollars)	(3) Carp control (thousands of dollars)	(4) Trash fish	(5) Game species	(6) Specific to cost (per acre-foot) $3	$5	$7
Iowa	60-65	5-10	-------	Buffalo, shad, carp, suckers, bullheads.	Bass, walleye, pan fish.	----	----	----
Kansas	-------	--------	-------	----------	----------	----	----	----
Kentucky	12	3	-------	Shad, buffalo, bluegill, catfish.	Black bass.	85	----	----
Louisiana	18	10	0	Gizzard shad, threadfish, shad, suckers, bream.	Largemouth bass, bream, crappie.	60	30	5
Maine	15-20	15-20	0	Perch, bullheads, white perch, pickerel.	Brook trout, landlocked salmon, smallmouth bass.	----	----	----
Maryland	10	.1	0	Perch, white suckers.	Channel catfish, bass, sunfish.	?	----	----
Massachusetts	50	30	0	Bullheads, sunfish, perch, suckers.	Trout, pickerel, bass.	----	----	----
Michigan	250	100	25	Bluegills, perch, suckers, bullheads, minnows.	Trout, pike, bass.	25	10	5
Minnesota	-------	--------	-------	----------	----------	----	----	----
Mississippi	15	15	-------	Gizzard shad, gar, buffalo, suckers, bluegill.	White crappie, bluegill, largemouth bass.	75	30	5
Missouri	3	3	0	Sunfish, bullheads.	Crappies, bass, channel catfish.	100	50	----

REPLIES TO THE QUESTIONNAIRE--Continued.

State	(1) Total control (thousands of dollars)	(2) Chemical control (thousands of dollars)	(3) Carp control (thousands of dollars)	(4) Trash fish	(5) Game species	(6) Specific to cost (per acre-foot) $3	$5	$7
Montana	50	50	25	Goldeye, squawfish, Utah chub, perch, suckers.	Trout, whitefish, walleyes.	----	----	----
Nebraska	-------	--------	-------	----------	----------	----	----	----
Nevada	Var.	--------	-------	Chubs, squawfish, yellow perch, sunfish.	Trout, bass, catfish.	----	----	----
New Hampshire	7	6	0	Bullhead, suckers, pickerel, perch, sunfish.	Brook trout, bass, pickerel, bullheads.	Neg.	Neg.	Neg.
New Jersey	10-30	2	.3	Pumpkinseed, golden shiner, perch, sucker, carp.	Trout, largemouth bass, pickerel.	90	40	20
New Mexico	-------	--------	-------	----------	----------	----	----	----
New York	50	45	5	Perch, sunfish, rock bass, bullheads, chubs, suckers.	Trout, bass, walleye.	----	----	----
North Carolina	4	4	0	Chubs, suckers, gar, grindle.	Bass, breams, trout.	----	----	----
North Dakota	55	15-20	5	Black bullheads, sucker, yellow perch.	Northern pike, walleye.	75	25	10
Ohio	20	8	.5	Bluegills, green sunfish.	Bass, walleye, muskellunge.	10	1	1

REPLIES TO THE QUESTIONNAIRE--Continued.

State	(1) Total control (thousands of dollars)	(2) Chemical control (thousands of dollars)	(3) Carp control (thousands of dollars)	(4) Trash fish	(5) Game species	(6) Specific to cost (per acre-foot) $3	$5	$7
Oklahoma	20	5	2	Suckers, carp, shad, buffalo, drum, catfish, bullheads.	Crappie, catfish.	100	80	50
Oregon	200	198	20	Roach, suckers, perch, squawfish.	Trout, salmon, steelhead.	50	20	5
Pennsylvania	-------	3	-------	Suckers, chubs, sunfish, catfish.	Trout, bass, pickerel, walleye, muskellunge.	50	25	10
Rhode Island	1.5	1.5	0	Sunfish, perch.	Trout, bass, pickerel.	100	100	50
South Carolina	-------	--------	-------	----------	----------	----	----	----
South Dakota	25	5	25	Crappies, perch, bluegill, bull-suckers, other sunfish.	Largemouth bass, walleye, northern pike, trout.	35	10	----
Tennessee	-------	--------	-------	----------	----------	----	----	----
Texas	-------	--------	-------	----------	----------	----	----	----
Utah	100	Var.	-------	Utah chub, yellow perch, suckers.	Trout, channel catfish, largemouth bass.	10	?	?
Vermont	-------	--------	-------	----------	----------	----	----	----
Virginia	25	10	?	Gizzard shad.	Crappie, bream, bass.	100	----	----
Washington	15	15	-------	Squawfish, sculpin, suckers, lamprey.	Rainbow, steelhead salmon.	50	30	10

REPLIES TO THE QUESTIONNAIRE--Continued.

State	(1) Total control (thousands of dollars)	(2) Chemical control (thousands of dollars)	(3) Carp control (thousands of dollars)	(4) Trash fish	(5) Game species	(6) Specific to cost (per acre-foot) $3	$5	$7
West Virginia---	1	0.1	0	Green sunfish.	Trout, bass, muskies.	----	----	----
Wisconsin-------	198	10	190	Sheepshead, pan fish (bluegills, perch, bullheads).	Walleye, muskies, northern pike.	50	25	10
Wyoming---------	15	6.75	15	Chubs, suckers, squawfish, perch.	Trout, crappie, perch, whitefish.	30	10	5
Puerto Rico-----	-------	--------	-------	Bluegill.	Largemouth bass, bluegill, catfish.	----	----	----
TVA-------------	-------	--------	-------	Gizzard shad.	----------	----	----	----
Total------	1,438	715	375					
Average----------						62	35	18

NOTE: Through oversight, the questionnaire was not sent to the State of Indiana.

badly out of balance as to require complete reclamation, and carp are really not too serious a problem. In fact, certain south Jersey impoundments and north Jersey rivers where they predominate are popular fishing areas for carp fishermen, and these license buyers would most certainly resent any attempt on our part to tamper with their sport.

"We are interested in specific poisons, as some of the enclosed literature will indicate. For example, we would very much like to be able to eradicate the pumpkinseed sunfish in most of our waters. We consider this fish our most undesirable, generally speaking.

"What we would also like to be able to do is to 'weed' out certain fish species alive and transfer them elsewhere. I would like to see a drug that would enable us to capture any desired fish species from a lake unharmed, tag it or remove it, then have the effects of the drug wear off with neither the lake nor the fish worse for the experience." (Roland F. Smith)

B. South and Southeast

Delaware

"In fish management work in Delaware, we consider the eradication of rough fish (carp, bullheads, golden shiner) and /reduction of/ over population of pan fish to be a wise technique. We feel the cost of a specific toxicant would not be a factor as this would be offset by better public relations and less expense in the attempt to save game fish. The greatest use Delaware would have for such a material would be for the control of carp." (Jay L. Harmic)

Maryland

"The Inland Fisheries Division of the Maryland Game and Inland Fish Commission is very much interested in the control of rough fish in inland waters of Maryland.

"Our present program has been the reclaiming of lakes and ponds through draining. Investigations are going forward with the study of improved nets and partial and complete chemical eradication. We believe that selective chemicals are the answer to the rough fish problem (carp, suckers, fallfish, stunted yellow perch, crappie and sunfish).

"We are pleased that state and Federal governments and private agencies are now undertaking to study the rough fish problem which will be a perennial one in many of our waters." (Edwin M. Barry)

Virginia

"If you develop a true specific for gizzard shad ... you can almost name your own price in the South and Southeast." (J. C. Fuller)

North Carolina

"The cost is not the limiting factor. In the public waters of the states, the main rivers and impoundments are sources of municipal water supply. We cannot use chemicals in rough fish control because, in the public mind, we have 'poisoned' the water if chemicals are introduced and especially if there is a residual odor or flavor as with emulsified rotenone. The greatest use of chemicals is for a selective toxicant for sunfish which will reduce their abundance without killing bass. Marginal poisoning with pelletized rotenone is partly effective." (J. H. Cornell)

Georgia

"This year we intend to make a selective kill of gizzard shad by use of rotenone in 10,000 acres of lakes and streams.

"The cost of the 5% emulsifiable rotenone is one of the chief reasons that more rough fish are not reduced in the large impoundments." (Fred J. Dickson)

TVA

"A cheap specific toxicant would find wider use than rotenone but regardless of its specificity, it must be cheap (as compared to rotenone) if it is to be widely used or used to the extent that it should be.

"Other properties that the chemical should have are:

1. Safe for operators.
2. Must not render fish flesh inedible.
3. Must not poison water for humans or livestock.

"... The cost of 5% emulsifiable rotenone now is the chief reason that more rough fish control work has not been done with this agent." (L. F. Miller)

Florida

"I feel that half of our rough fish control budget would be spent on a selective poisoning program regardless of the costs as mentioned above. The deciding factor would be the effectiveness of the product. Of course, the more economical the price, the more waters that could be treated." (E. T. Heinen)

Alabama

"I am sure there will be a considerable market in Alabama for a chemical that would thin crowded bream populations (bluegill and shell cracker) without killing largemouth bass." (I. B. Byrd)

Louisiana

"Since shad is our biggest problem, small doses of rotenone work well as a selective toxicant." (Harry E. Schafer, Jr.)

Mississippi

"If you can develop compounds that will be specific to any one species, I am sure the fisheries biologists will be eternally grateful." (Barry O. Freeman)

Kentucky

"We are greatly interested in specific chemical fish toxicants as a management tool in Kentucky fishing waters, especially in our large reservoirs.

"For the past two years we have been selectively treating two lakes, one about 6,000 acres and one about 1,100 acres, for the removal of gizzard shad. While we can drastically reduce the population at any given time, so far it has been impossible to eliminate the species and therefore it makes a rapid comeback the following year.

"If you could develop a specific poison which would eliminate all except two or three desired species, there would be more than a substantial demand for said chemical providing the cost was within reason." (Minor E. Clark)

C. North Central

Ohio

"In private ponds, of which there are over 14,000 in Ohio, cost would not be a significant factor since the total expenditure per pond would be low.

"... carp are very desirable in certain areas of the state and by certain individuals throughout the state as a sport fish and as a food fish. There is a large commercial take of carp in the Lake Erie area. ... large numbers of stunted bluegills and green sunfish in public and private waters are unquestionably a problem ... The use of fish toxicants ..., being used more and more for sport species control as well as complete eradication." (David Papier)

Michigan

"The field of manipulating fish populations with chemicals and mechanical devices to increase production of the desirable species will expand rapidly with the development of new techniques. It seems that new toxicants could be developed along four lines, namely:

1. Improved non-specific toxicants which would give more complete kills.
2. A non-specific toxicant with better anesthetizing effects to allow salvage of desirable fish.
3. Specific species toxicants for carp, bullheads, suckers and bluegills.
4. Toxicants specific to the young of various species at some point from the egg to the fry stage.

"Any developments along these lines would be helpful. The acreage of waters in need of improvement is tremendous, hence chemicals low in cost could easily cover a wide market. High-priced chemicals, no matter how effective, would be limited in use directly in ratio to the price." (Wayne H. Tody)

Wisconsin

"A selective inexpensive fish toxicant would be of great value to Fish Management.

"Desirable characteristics are:

1. Low cost.
2. Easily applied.
3. Efficient.
4. Spontaneous decomposition to non-toxic conditions.
5. Non-toxic to warm-blooded animals.
6. Specific for particular species of fish.
7. Unaffected by temperature --can be used under ice.

"The use of toxicants in fish management is growing rapidly and the possibilities of such use seem almost unlimited if the proper materials become available. The sportsmen in Wisconsin are accepting the practice very readily and in many instances are very enthusiastic about the results that have been obtained. In addition, the sportsmen organizations, as well as town and country boards, have cooperated in the application of toxicants to given bodies of water and have contributed both manpower and financial assistance. We anticipate that in the near future the use of toxicants in fish management will be a standard operating procedure rather than the present special project category." (Edward Schneberger)

Missouri

"Our biologists believe that a market would develop in this State for a specific toxicant of moderate cost. They also feel that research should be done to develop spermatocides and possibly ovicides for controlling fish populations.

"The Missouri Wildlife Code provides that no toxicant of any type may be used except under the direct supervision of the Conservation Commission and this would prohibit distribution to the general public." (Larry R. Gale)

Iowa

"In the past two years the Biology and Fisheries Departments of the Commission have cooperatively treated several lakes and a section of about 20 miles of the Des Moines River (between two dams) with rotenone. We plan to expand this work in the future." (E. B. Speaker)

Illinois

"Any private individual or governmental agency who has a water area with rough or commercial fish must contract with a commercial fisherman. The commercial fisherman, in return for being given the opportunity to remove these species, in many cases pays the owner of the water area an agreed amount per pound of fish removed." (William J. Harth)

South Dakota

"A new method of carp control would result in an immediate expansion of effort, provided it was practical and within economic reach. ... Total effort to re-establish balanced fish populations will have to be expanded several times." (William D. Clothier)

North Dakota

"After ten years of rather intensive use of chemicals in lake rehabilitation work, we are convinced that this type of management is of extreme importance in the over-all management picture. We are just as convinced that chemical rehabilitation is still in its infancy so far as available toxicants are concerned.

"For the fishery manager to have at his disposal specific toxicants could well prove to be the biggest single forward step in modern-day fishery management techniques.

"We would view with enthusiasm research pointed towards the development of specific fish toxicants and would lend all assistance possible along this line." (Dale L. Henegar)

D. West

Colorado

"Many of our waters which need reclamation by fish toxicants are inter-connected via irrigation canals, and a complete fish population eradication seems to last for a period of only three to five years

before reinfestation of rough species occurs through the irrigation ditches. A specific toxicant which would affect certain rough fish species would be an invaluable tool in the fisheries management of such waters." (W. R. Seaman)

Utah

"If the costs were comparable, a specific toxicant would probably have its greatest use in streams. Cost and incomplete kills are the major items which are limiting rough fish control programs at the present time. If these disadvantages could be overcome, rough fish control programs would 'mushroom' throughout the nation." (D. Andriano)

Arizona

"If chemicals can be compounded which would affect only certain species of trash fish, the increased cost of material per acre-foot would be justified." (P. S. McNeil, Jr.)

Nevada

"We feel that a specific poison would be definitely desirable and advantageous. Undoubtedly it would be utilized by all the state departments and Federal Government." (A. Jack Dieringer)

California

"Toxaphene has frequently been suggested to us as a general toxicant because it is comparatively inexpensive. We have not used it, however, because we think it is extremely dangerous and because waters treated with it take too long to detoxify.

"We have a number of very large lakes and reservoirs from which we would like to eliminate carp and other rough fish. But we cannot justify an expenditure of even $1.05 an acre-foot for the materials unless we are sure of obtaining a complete kill.

"One of our greatest needs for a specific toxicant is for the control of certain species of rough fish in streams inhabited by trout and salmon. For example, we would like very much to eliminate the Sacramento squawfish (Ptychocheilus grandis) from most of our salmon and trout waters in the upper Sacramento River drainage. We do not want to sacrifice a year class of salmon or steelhead in any stream to do the job." (Elton D. Bailey)

Oregon

"We are in need of specific chemicals to kill yellow perch, lamprey eels, squawfish and bullhead catfish. The need for specifics is increasing in Western waters. Many worthwhile projects must be delayed because of danger to salmon and steelhead populations. Specific chemicals would permit unlimited rehabilitation work in large river systems." (Robert L. Borovicka)

Washington

"... We, of the Fisheries Department, are in the process of developing a fish farming program, in both fresh and salt water, and are rapidly increasing the amount of rotenone used. ... It is anticipated that each area used for fish farming will be poisoned annually. This would amount to several thousand acres annually." (Dale Schoeneman)

Idaho

"What we need most is a good surefire toxicant that is cheap enough to permit Fish and Game agencies to treat large bodies of water. We also need specific toxicants which would eliminate squawfish, Utah chubs, carp and tench from trout waters." (James C. Simpson)

Montana

"I anticipate that specific fish toxicants would be enthusiastically received by fish managers across the country as well as in this state. However, even the cost of the present rotenone-based fish toxicants limits their use, so no doubt the cost of specifics would be of prime importance.

"We have several large reservoirs overrun with carp, chubs or squawfish on which we would undertake a complete fish eradication job if a cheap enough chemical were available. Of course, specific toxicants would be preferable since the game

fish would survive, saving time as well as restocking costs, but the costs shown on your questionnaire for these specific toxicants would likewise be prohibitive.

"Elimination of undesirable fish from an entire drainage has been attempted in the last few years. Here specifics would be particularly valuable since complete fish eradication from a drainage can cause extensive losses to desirable species, some of which might not be replaceable.

"No doubt there will be certain situations where the use of specific fish toxicants, even though expensive, will be justifiable." (George D. Holton)

Conclusion

Though there is a healthy diversity of opinion among aquatic biologists, it seems reasonable to conclude that each area of the United States has fishery-management problems peculiar to the region.

1. New England wants a general toxicant superior to rotenone.
2. The South and Southeast want to eradicate gizzard shad from bass waters.
3. The North Central region wants to eradicate carp in many waters. (This problem extends east to Maryland and Delaware and west through the Mountain States.)
4. The Mountain States and West Coast States want to eradicate carp and suckers from trout waters.

In addition to these, there are many other management problems, including reduction of some populations of sport fish.

To attack this multiplicity of problems, laboratory testing of a maximum number of species should be accomplished. By testing each candidate chemical on a large number of species and using various techniques to take advantage of the most vulnerable stages of each species, the probability of finding specific toxicants for each and--as a byproduct--improved general toxicants, ovicides, spermatocides, anesthetics, repellents, and possibly even therapeutic agents is increased. When promising chemicals are found by laboratory techniques, practical tests on a larger scale can be made.

The solution of these problems will probably be slow and difficult. Even after an effective chemical is found, there will be problems of state laws, public opinion, and political obstacles. Nevertheless, this general line of attack offers the best promise of solving many of the fishery-management problems of the conservation agencies.

Acknowledgments

I am grateful to the authorities quoted here for the time and effort they have generously expended to make this survey as complete as possible.

I am especially indebted to Dr. V. C. Applegate of the Bureau of Commercial Fisheries, whose now famous researches on the chemical control of the sea lamprey in the Great Lakes should be a classic for all time. This work demonstrated the broad possibilities and pointed the way.

Cooperation with H. A. Loeb of the New York State Conservation Department on a carp-control project indicated the need for the survey.

Anise, clove, wintergreen, spike, cod liver, rose, castor, orange, citronella, mint, and bergamot were tested by Texas fishery workers in an effort to make gelatin capsules containing calcium carbide more attractive to undesirable bottom-feeding fish. The first three oils were excellent in odor-retention properties in both air and water, the next six were fair to good, and the last two were poor to weak.

RESISTANCE TO ULCER DISEASE AND FURUNCULOSIS IN EASTERN BROOK TROUT, *SALVELINUS FONTINALIS*

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IN RECENT YEARS CONSIDERABLE PROGRESS has been made on sulfonamide and antibiotic therapy and prophylaxis of infectious diseases of fishes. These drugs are effective in the control of some bacterial diseases. The effect of the drugs stops, however, as soon as they are withdrawn, and recurrence or reinfection takes place frequently. Usefulness of drugs is also limited by the ease with which drug-resistant strains of the pathogens appear. This has been demonstrated recently in outbreaks of fish furunculosis which became refractory to treatment with sulfonamides (Snieszko and Bullock 1957).

Strains of fish that inherit natural resistance to infectious diseases usually retain that natural resistance throughout their existence, so that the fish have few or no mortalities resulting from those diseases. From the practical point of view, selection and breeding of disease-resistant fish should furnish more effective control of losses. The progress made before 1953 in the selection and breeding of disease-resistant strains of eastern brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) was reviewed by Wolf (1954). In that paper he included observations on resistance to furunculosis and ulcer disease among 11 strains of brook trout and 7 strains of brown trout maintained at various hatcheries in the United States. In this paper we present results of experiments that we made in order to determine the degree of resistance to ulcer disease and furunculosis among four strains of brook trout, each from a different hatchery. A preliminary report on these findings has been published (Snieszko 1957).

Experimental Methods

Fingerling eastern brook trout were used in all tests. The trout were received late in the fall as eyed eggs from the Federal hatchery at Berlin, New Hampshire, and the State hatcheries at Bellefonte, Pennsylvania, and Beaver Creek, Maryland. Trout from the Federal hatchery at Erwin, Tennessee, were received as fingerlings in May 1955. From the time they were received, all fish were maintained under similar conditions: temperature of the water was constant between 12° and 13° C. (54° to 55° F.); all fish were started on a beef liver diet and gradually transferred to the Cortland No. 6 diet at feeding rates based on the New York State feeding charts.

The experimental fish were exposed to furunculosis and ulcer disease in troughs containing naturally infected brook trout, were injected intramuscularly, or were fed bacterial cultures. The essentials of each experiment, initial number and

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weight of fish, and the mortalities are presented in the tables and figures. The mortalities presented graphically were calculated as percentages of residual live fish at the beginning of each 10-day period. To obtain smooth curves, averages were calculated from several 10-day periods when losses occurred at low rates.

Results

The first experiment was made with eastern brook trout fingerlings hatched at Leetown in the fall of 1953 from eggs received from Bellefonte, Pennsylvania, and Berlin, New Hampshire. Ulcer disease appeared without artificial infection in a non-experimental lot of Berlin trout and was diagnosed bacteriologically on June 16 to 18, 1954. On June 18, 1500-gram aliquots of Berlin trout having an average weight of 12.2 grams were distributed among three experimental troughs. These trout were taken from the trough in which the presence of ulcer disease had just been established. The same quantities of Bellefonte trout having an average weight of 9.8 grams were distributed in three other troughs.[1/] Twelve trout from the infected lot of Berlin trout were added to each trough containing Bellefonte trout.

In order to determine whether any other bacterial disease (furunculosis, for example) affected the experimental fish during the test, some of the trout that died were selected at random for bacteriological examination. Hemophilus piscium, the cause of ulcer disease, was isolated in pure culture from 30 of the 43 dead Bellefonte trout examined. No bacteria of any kind were isolated from the remaining 13 trout. The same bacterium was also isolated in pure culture from a similar proportion of the Berlin trout. This experiment was run for 220 days.

It is evident from figure 1 that the course of ulcer disease was different in the two strains of trout. In the susceptible Berlin trout, losses were more acute and amounted to 86 percent. In the infected Bellefonte trout, mortalities totaled 51 percent (table 1). Under normal hatchery operations as carried on at this station, ulcer disease did not appear during the entire time these fish remained at the Leetown hatchery (until March 1955). Held under the same conditions, the Berlin trout were almost wiped out by ulcer disease by midsummer of 1954.

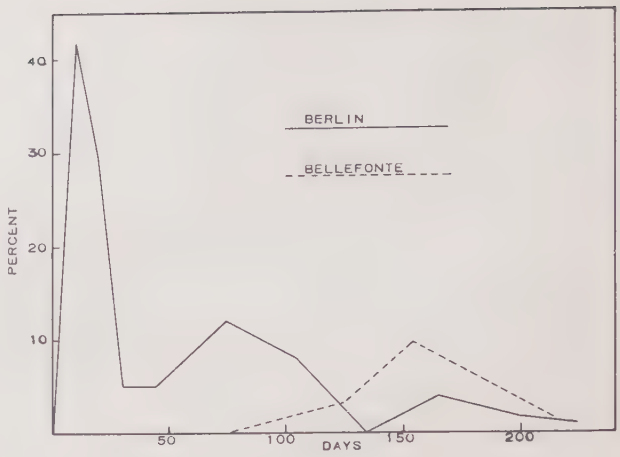

FIGURE 1.--Ulcer-disease mortality rates of Berlin and Bellefonte brook trout.

The second experiment was performed with Berlin, Bellefonte, and Maryland trout. This experiment was started on July 30, 1954. Until that date, none of these trout had shown any signs of ulcer disease or furunculosis. Forty trout from

TABLE 1.--Mortalities in two strains of fingerling brook trout infected with ulcer disease

	Berlin, N. H.		Bellefonte, Pa.	
	Trough No.		Trough No.	
	3B	3C	5B	5C
Initial number of trout per trough	138	109	148	160
Total mortalities per trough, percent	80	93	51	51
Average mortalities, percent	86		51	

[1/] Note the difference in the weights, which represent different growth rates.

each strain, a total of 120, were placed in each of the 4 experimental troughs (table 2). The average weight per fish was: Berlin trout, 23.0 grams; Bellefonte trout, 19.5 grams; Maryland trout, 13.6 grams. The weight of trout per trough averaged 2,245 grams. Each strain of fish was marked by clipping one of the fins. This experiment was continued for 174 days.

In three troughs, five fish of each strain were inoculated intramuscularly with 0.2 milliliter of a suspension of freshly prepared culture of Hemophilus piscium. In the fourth trough (7A), 15 fish were injected in the same way with saline. This trough was to serve as a check for the presence of latent infection in the experimental fish or for an accidental transmission of disease. The first deaths among the inoculated fish occurred in 4 days. On the ninth day, the first death caused by ulcer disease occurred in trough 7A (table 2). Furunculosis was found to be present in trough 1C on the 33d day and in trough 7A on the 47th day. In troughs 1A and 1B, furunculosis did not occur during the experiment. As disease occurred in the check trough (7A), results were calculated from four instead of three replicates (table 2 and figure 2). Complications caused by furunculosis in troughs 1C and 7A apparently did not affect the results, as the differences in mortality among all four troughs were surprisingly small and therefore insignificant (table 2).

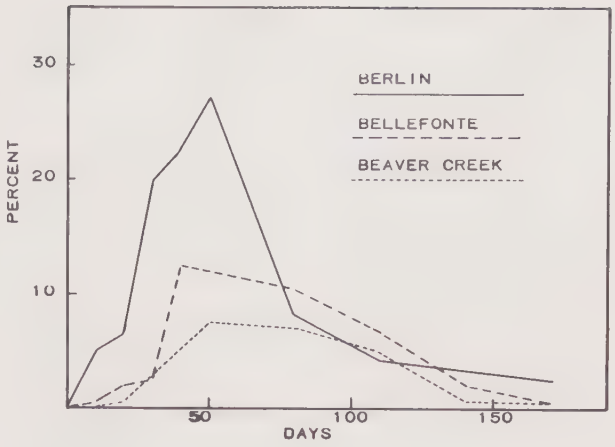

FIGURE 2.--Mortality rates from ulcer disease and furunculosis in three strains of brook trout.

The results of this experiment show that resistance to ulcer disease and furunculosis was lowest in the Berlin trout, highest in the Beaver Creek trout, and intermediate in the Bellefonte trout. The results of bacteriological examinations of dead fish selected at random during the experiment are summarized in table 3. It is interesting to note that bacteriological examination showed that mortalities

TABLE 2.--Mortalities caused by ulcer disease and furunculosis among three strains of fingerling brook trout kept mixed together

	Berlin, N. H.				Bellefonte, Pa.				Beaver Creek, Md.			
	Trough No.				Trough No.				Trough No.			
	1A	1B	1C	7A	1A	1B	1C	7A	1A	1B	1C	7A
Initial number of trout---	40	40	40	40	40	40	40	40	40	40	40	40
Diseases present----------	U[1]	U	UF[2]	UF	U	U	UF	UF	U	U	UF	UF
Total mortalities, percent	80	77	72	80	70	60	62	62	47	55	47	45
Average total mortalities:												
According to disease---	78.5		76.0		65		62		51		46	
According to strain of trout----------	77				63.5				48.5			

Mortalities per trough, percent: 1A, 66; 1B, 64; 1C, 60; 7A, 62.

Mortalities per disease, percent: ulcer disease, 65; ulcer disease and furunculosis, 61.

[1]/U = ulcer disease. [2]/UF = ulcer disease and furunculosis.

TABLE 3.--Results of bacteriological examination of dead trout selected at random during experiment No. 2

Pathogen isolated	Trough No.			
	1A	1B	1C	7A
Hemophilus piscium-----	39	31	6	38
Aeromonas salmonicida--	0	0	29	3
Total----------	39	31	35	41

were caused by either Aeromonas salmonicida or Hemophilus piscium. Although the total mortalities in all four troughs were similar, most of the deaths in any single trough were caused by one of the two pathogens.

In the third experiment, three strains of brook trout were tested, both in separate troughs and mixed together, to determine the effect of such mixing on the incidence of the disease or the number of mortalities. The average weight per fish as determined before distribution was: Erwin trout, 7.8 grams; Berlin trout, 18.9 grams; Bellefonte trout, 13.2 grams.

Fish were distributed to experimental troughs on June 20 and 21, 1955. On June 23 and 24, 3-day-old cultures of A. salmonicida and H. piscium were incorporated in their feed. The results are presented in tables 4 and 5 and figure 3. This experiment was carried on for 30 days, during which time most of the trout died.

As in the first two experiments, the differences in the mortality rates of the two susceptible strains of trout and the resistant strain were significant. There were no consistent differences between the mortality rates in troughs containing all three strains together and the mortality rates in troughs in which each strain was kept separately. It is likely that losses in resistant strains would have reached higher figures if this experiment had been continued for a longer period.

Discussion

Results presented in this paper furnish additional evidence for the existence of significant differences in the inherent resistance of different strains of brook trout either to ulcer disease alone or to a mixed infection caused by ulcer disease and furunculosis. Similar differences were observed by Wolf (1954) under different conditions with strains of brook trout obtained from the Bellefonte and Berlin hatcheries. As might be expected from the results obtained with other animals (Schneider 1956), the specific susceptibility or resistance of different strains of tested brook trout was not absolute. It is generally recognized that the relative severity of infection is influenced by the genetic makeup of both the host and the pathogen, and that resistant strains of animals may be infected, become diseased, and die if virulence of infecting pathogens is high.

The difference between resistant and susceptible strains of brook trout is evident from the rate of mortalities and total mortalities, but all the strains of our

TABLE 4.--Mortalities among three strains of fingerling brook trout kept in separate troughs and infected orally with cultures of Aeromonas salmonicida and Hemophilus piscium

/Trout were distributed at a rate of 1,500 grams per trough./

	Erwin, Tenn.		Berlin, N. H.		Bellefonte, Pa.	
	Trough No.		Trough No.		Trough No.	
	6	10	5	11	4	12
Initial number of trout----------	195	210	69	78	104	116
Total mortalities, percent----------	97.5	97.0	91.5	78.0	7.7	14.6
Average total mortalities, percent------	97.0		84.5		11.4	

experimental trout became infected. This probably was due to the fact that the fish used in these experiments were continuously exposed to infection from the diseased fish present in the same troughs. The brook trout that were kept at the Leetown hatchery in production tanks and ponds were exposed only to a chance infection. Losses among the susceptible strains were almost complete within a few weeks, whereas neither ulcer disease nor furunculosis was noticed in the resistant Bellefonte or Beaver Creek brook trout during the entire time (15 to 16 months) they remained at the hatchery. A symptomless latent infection probably was present in the production trout from Bellefonte, because when a few were exposed to a higher temperature (18° C., 65° F.) in the course of a different experiment, some developed typical furunculosis and died.

From the data presented it is evident that there is a real or apparent relationship between the rate of growth of the tested strains of trout, as expressed by their weight, and their relative susceptibility to fatal infection with one or both of the diseases tested. The fastest growing strains of fish showed increased rates of mortality. The trout from Erwin were an exception, but they should be excluded from this comparison at this time. In contrast to the other strains used in these experiments, the Erwin trout were raised at the Erwin Station and shipped to Leetown only about a month before their use in the experiment. Therefore, the rate of their weight gain cannot be compared with those of the other three strains of trout.

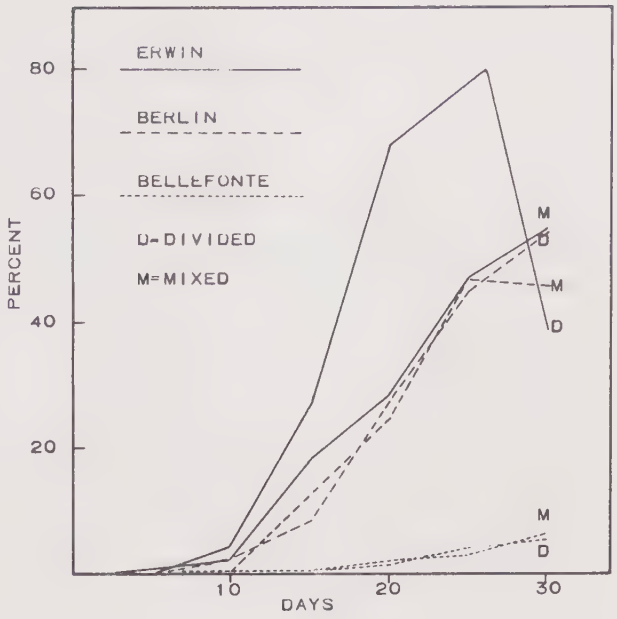

FIGURE 3.--Mortality rates from ulcer disease and furunculosis in three strains of brook trout.

An important warning must be given. It is evident from the observations made by Embody and Hayford (1925), Davis (1953), and Wolf (1954), and from the results presented in this paper, that among different hatchery strains of brook trout there exist considerable differences in the degree of resistance to ulcer disease--

TABLE 5.--Mortalities among three strains of fingerling brook trout mixed together and infected orally with cultures of Aeromonas salmonicida and Hemophilus piscium

[Trout were distributed at a rate of 500 grams per strain and trough.]

	Erwin, Tenn.				Berlin, N. H.				Bellefonte, Pa.			
	Trough No.				Trough No.				Trough No.			
	1	7	2	8	1	7	2	8	1	7	2	8
Initial number of trout	57	64	62	60	32	32	23	30	34	40	34	40
Mortalities, percent	86.0	87.5	76.0	96.0	59.0	91.0	70.0	100.0	8.8	12.5	8.8	17.5
Average mortalities, percent		86.0				80.0				12.0		

alone or with furunculosis. Under normal hatchery operations, as carried on at Leetown, the susceptible strains of trout could not be raised without almost total loss from ulcer disease, furunculosis, or both. The resistant strains could be raised simultaneously without any losses which could be attributed to these diseases. It is evident that differences in inherited disease resistance among different strains of trout do occur and are of practical importance. However, unless a determined effort is made to maintain disease-resistant strains through deliberate selection and breeding, such valuable strains of brook trout may gradually become more susceptible or may be lost entirely.

Summary

Four different strains of brook trout (obtained from trout hatcheries at Beaver Creek, Maryland; Bellefonte, Pennsylvania; Berlin, New Hampshire; and Erwin, Tennessee) were exposed to infection with organisms causing either ulcer disease or ulcer disease and furunculosis. Observations were made for periods ranging from 1 to 7 months. In the susceptible strains of brook trout (Berlin, New Hampshire, and Erwin, Tennessee), experimental infections caused faster progressing diseases and higher mortalities. Mortalities occurred at similar rates, whether ulcer disease was present alone or with furunculosis. There was also a correlation, real or apparent, between weight gain of trout and their resistance to disease, the slower growing fish appearing to be more resistant.

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A tank was loaded with 70 pounds of fish and left until the fish became distressed. The fish were removed, the oxygen content was measured, and the water was then bailed for 5 minutes with a pail. The oxygen concentration was 10 p. p. m. when the fish were introduced; the fish reduced it to 3 p. p. m., and bailing brought it up to 8.4 p. p. m. in 5 minutes. Evidently bailing is an effective method of aeration. -- From "Carbon Dioxide as a Limiting Factor in Trout Transportation" by D. C. Haskell and R. O. Davies. New York Fish and Game Journal, 5 (2): 178-179.

THE USE OF HUMAN CHORIONIC GONADOTROPHIN TO SPAWN WARM-WATER FISHES

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and
Howard P. Clemens, University of Oklahoma, Norman, Oklahoma

IN PREVIOUS PAPERS WE HAVE REPORTED the use of pituitary materials to spawn channel catfish (Clemens and Sneed 1957; Sneed and Clemens, in press) and described in considerable detail the application of this method to the spawning and culture of several species of warm-water fish. 1/ Pickford and Atz (1957) reviewed the subject of gonadotrophins and the responses of fish to these hormones.

Recently Ramaswami and Sundararaj (1958) spawned Indian catfish with injections of human chorionic gonadotrophins. Earlier workers injected mammalian hormones, including human chorionic gonadotrophins, in attempts to induce fish to spawn. Pickford and Atz (1957) reported numerous experiments with mammalian gonadotrophins, only a few of which were active in fishes. None of the previous studies appear to have been of sufficient scope to establish a technique for the use of human chorionic gonadotrophin in fish-cultural procedures. The data presented in this paper establish a method for spawning channel catfish, goldfish, and white crappie with injections of chorionic gonadotrophin; and the experiments were of sufficient size to approximate commercial production of goldfish and channel catfish.

Pituitary-induced spawning in hatchery fish has many advantages (Clemens and Sneed, in press): the use of human chorionic gonadotrophin enhances these advantages. As the hormones are readily available at drugstores throughout the country, the collection, preservation, storage, and preparation for injection of fish pituitaries are no longer necessary. Even the number of injections in catfish has been reduced from three to one, a great saving in time due to decreased handling of fish and materials. Also, the fish survive the rigorous spawning act in better condition as a result of less handling.

There are a number of brands of human chorionic gonadotrophin available, but we have tested sufficiently only one--APL (Anterior Pituitary Like), produced by Ayerst Laboratories, New York. It can be obtained as a powder or liquid. The present fair-trade price is $12.35 for 10,000 international units (IU), or $7.50 for 5,000 IU. The same company markets a veterinary grade that sells for $5.65 for 10,000 IU. We have not tried this preparation. The company foresees the possible release of APL in a form suitable for fishery work and inexpensive enough for extensive use. At a price of $5.65 per 10,000 units, the cost of spawning a 1-pound fish is about 45 cents, which is comparable to the estimated cost of pituitary injections.

1/ Clemens, H. P., and Sneed, K. E. The bioassay and use of pituitary materials in spawning warm-water fishes, with notes relative to fish-cultural practices. In manuscript.

The authors are entitled to equal credit for this paper.

The facilities and method of injection were described by Sneed and Clemens (in press).

Results

In the original experiment (table 1) conducted to test the activity of APL, we injected 10 female goldfish (5 to 7 inches in length) with doses ranging from 10 to 1,600 IU. The volume of each dose ranged from 0.02 to 3.2 milliliters. Only those females which received 100 or more IU ovulated. The four fish injected with less than 100 IU of APL and the control fish did not ovulate and could not be handstripped.

Other goldfish were injected at the same time with doses of 0.2 to 3.0 milligrams of acetone-dried carp pituitary in volumes of distilled water ranging from 0.1 to 3.5 milliliters. One of the three fish injected with the smallest amount of pituitary and all the females that received the larger dosages ovulated in 20 to 22 hours (table 1). It appeared that under the conditions of this experiment, 100 IU of APL was comparable to 0.5 milligram of acetone-dried pituitary. Dosages will vary, however, as the physiological condition of a particular group of fish and the conditions of the experiments vary.

TABLE 1.-- Relationship of APL dosages in international units to pituitary dosages in milligrams when injected into ripe female goldfish weighing approximately 100 grams each

Dosage of APL (IU per fish)	Response	Dosage of pituitary (milligrams per fish)	Response
Control------	3 negative	----------	----------
10------	3 negative	----------	----------
20------	3 negative	----------	----------
40------	3 negative	----------	----------
80------	3 negative	0.2	(1 ovulated (2 negative.
100------	3 ovulated	.5	3 ovulated.
160------	3 ovulated	1.0	3 ovulated.
200------	3 ovulated	1.5	3 ovulated.
400------	3 ovulated	3.0	3 ovulated.
800------	3 ovulated	----------	----------
1,600------	3 ovulated	----------	----------

Another experiment was conducted with 57 goldfish. Results were similar, except that some fish responded to dosages of APL as low as 25 IU when given in two injections 6 days apart (table 2).

The females of three pairs of white crappie (each fish weighing about 1 pound)

TABLE 2.--The response of female goldfish to varying doses of APL

[Temperatures ranged from 59° to 66° F. from the beginning to the end of the experimental period.]

Injection	Number injected	Number of ovulating females each day								Size of fish (inches)
		0	1	2	3	4	5	6	7	
Dosage of APL per fish:										
25 IU----------	7	X	1	0	0	0	0	X	4	3 to 5
50 IU----------	5	X	0	0	0	0	0	X	2	3 to 5
75 IU----------	5	X	0	0	0	0	0	X	3	3 to 5
100 IU----------	10	X	7	0	0	0	0	0	0	7 to 12
200 IU----------	10	X	8	0	0	0	0	0	0	7 to 12
Acetone-dried buffalo pituitary, 5 mm.----------	20	X	14	0	0	0	0	0	0	7 to 12

X = Day of injection.

TABLE 3.--Dosages of APL required to spawn channel catfish, June 1958

Weight of female (pounds)	Dosage (IU per pound/time)	Elapsed time in days											Total IU per pound received	Time of last injection to spawn (hours)
		0	1	2	3	4	5	6	7	8	9	10		
1.8	100 - 8 hours	XX	XXX	XX	S	---	---	---	---	---	---	---	700	24
2.1	100 - 8 hours	XX	XXX	XX	S	---	---	---	---	---	---	---	700	5
1.6	100 - 8 hours	XX	XXX	PXX	X	IS	---	---	---	---	---	---	700	----------
1.3	300 - 24 hours	X	X	X	S	---	---	---	---	---	---	---	900	16
1.6	300 - 24 hours	X	S	---	---	---	---	---	---	---	---	---	300	16
1.7	300 - 24 hours	X	X	X	S	---	---	---	---	---	---	---	900	16
1.3	1,000	X	S	---	---	---	---	---	---	---	---	---	1,000	47
2.1	1,000	X	S	---	---	---	---	---	---	---	---	---	1,000	26 to 32
2.8	600	X	---	X	X	X	P	---	---	IS	---	---	------	----------
2.6	600	X	---	X	X	X	P	---	P	P	P	S	------	----------
4.5	700	X	---	S	---	---	---	---	---	---	---	---	700	30 to 44
8.2	700	X	---	S	---	---	---	---	---	---	---	---	700	30 to 38
3.6	800	X	---	S	---	---	---	---	---	---	---	---	800	30 to 38
3.5	800	X	---	S	---	---	---	---	---	---	---	---	800	30 to 44
4.1	800	X	---	S	---	---	---	---	---	---	---	---	800	30 to 44
2.2	900	X	---	---	---	200	200	300	P	---	IS	Y	900	----------
2.2	900	X	---	IS	---	---	---	---	---	---	---	---	900	30 to 44
3.4	900	X	---	S	---	---	---	---	---	---	---	---	900	30 to 44
2.4	1,000	X	---	S	---	---	---	---	---	---	---	---	1,000	30 to 38
1.7	1,000	X	---	S	---	---	---	---	---	---	---	---	1,000	30 to 38
1.5	1,000	X	---	S	---	---	---	---	---	---	---	---	1,000	30 to 44

X = Injected with APL.
S = Spawn.
IS = Incomplete spawn.
P = Pituitary injections of 2 milligrams per pound.
Y = Fish received 6 daily pituitary injections before incomplete spawn.

were injected with 1,000, 1,500, and 2,000 IU, respectively, of APL and were placed with males in a 55-gallon aquarium. The females that received the two higher injections spawned 3 days after they were injected.

In another experiment, two female white crappie were injected with 1,000 IU of APL and one of these fish spawned 2 days later at a water temperature of 62° F.

Thirty-nine channel catfish that weighed from 1.4 to 5.0 pounds were spawned with APL injections. The size and frequency of the dosages were varied in the first experiments with 21 females (table 3). Dosages ranged from 100 IU every 8 hours to 1,000 IU per pound of fish every 24 hours. Fish spawned at all dosage levels, but lower dosages required more injections. Females responded to one injection of 700 IU or more per pound of fish, whereas those females that received 100 IU per pound required seven injections. In other words, fish spawned when they had received 700 IU in either one or seven injections. During this series of experiments, one female spawned after a single injection of 300 IU per pound, which indicated that lower dosages will induce spawning in some fish. The 800 IU per pound which we recommend, therefore, reflected the physiological condition of the fish used in this particular experiment; and this dosage was used successfully for the remainder of the 1958 spawning season.

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In press. Spawning channel catfish, Ictalurus punctatus in aquaria by injection of fish pituitaries. U.S.D.I., Fish and Wildl. Serv., Fish. Bull.

MATERIAL DESIRED FOR RESEARCH ON FUNGUS

It is generally assumed that Saprolegnia is the one and only fungus of importance to fish culture. Actually there are many kinds of fungus infections, and failure to recognize these may account for some of the difficulties encountered in treatment.

A program of research on fungi pathogenic or parasitic to fish has been begun at the Virginia Polytechnic Institute. The cooperation of Federal and State fishery biologists and hatchery managers is requested in order that the work may include material--fungi from dead and live fish, fungus-infected fish and eggs, and fungus cultures--from all parts of the country.

Anyone having such material should send his name and address on a card to:

Dr. William W. Scott
Department of Biology
Virginia Polytechnic Institute
Blacksburg, Virginia.

Dr. Scott will supply containers and full information about handling and shipping the material. When possible, he will also identify the fungus, provide a pure culture, and recommend methods of treatment.

OBSERVATIONS ON THREE RECLAIMED TROUT PONDS IN MASSACHUSETTS

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Massachusetts Division of Fisheries and Game
Westboro, Massachusetts

THE REHABILITATION OF PONDS SUITABLE FOR TROUT through chemical eradication and restocking has become an increasingly important fishery-management technique. In Washington State, a catch of 3 million trout (1.6 million pounds) from reclaimed waters by 400,000 fishermen on opening day alone offers an unparalleled testimonial to the validity of the principle involved (Stroud 1958). Published follow-through work, however, is in conspicuously short supply, with some noteworthy exceptions. In the Northeast, information on stocking rates, incomplete kills, recontamination, carrying capacity, and production is needed for the refinement of the technique as it applies to the relatively infertile waters of the area.

This paper presents the case histories of three reclaimed trout ponds in Massachusetts. Admittedly, there are many gaps in these histories, and the limitations of these data preclude finite solutions to the problems cited. Unquestionably, judging from the acceptance and magnitude of such programing in almost all areas of North America confronted with the need to produce trout fishing, similar information reposes in conservation department files. Publication of this material and subsequent analysis in total could conceivably produce valid conclusions, generally and specifically applicable.

Higgins Pond, Brewster, Massachusetts

This pond is located in the relatively infertile sandy soils of outer Cape Cod at an elevation of 24 feet above sea level. It has a surface area of 25 acres, a maximum depth of 67 feet, an average depth of 28 feet, and neither inlet nor outlet. Stratification occurs in the summer, and a 31-foot layer of trout water (70° F. or less, and containing 5 p.p.m. or more of oxygen) is usually present. This layer of trout water generally lies between 26 and 57 feet. It makes up 26 percent of the total water volume, and about 7 acres of pond bottom is exposed to it. Water transparency is 22 feet. Methyl orange alkalinity in August runs from 6.0 p.p.m. at the surface to 8.0 p.p.m. at the bottom. The pH varies vertically from 6.8 to 5.2. Sand and some mud predominate as bottom types.

Reclamation occurred late in September 1950, when a combination of emulsifiable and powdered rotenone was used to achieve a concentration of 0.5 p.p.m. Weighted porous bags filled with toxic paste were dragged in all waters more than 35 feet deep. About 900 pounds of warm-water fishes was believed to have been present and killed, although only 820 pounds was actually found and collected. (It is recognized that all fish killed may not be recovered on reclamation. This is due to a variety of factors including depth, conformation of pond basin, turbidity, excessive vegetation, and water stratification. All these factors were at minimum in the fish recoveries reported. The figures for standing population are considered close to correct.) The population consisted largely of stunted yellow perch

(Perca flavescens), golden shiner (Notemigonus crysoleucas), brown bullhead (Ameiurus nebulosus), killifish (Fundulus diaphanus), and a few chain pickerel (Esox niger). Also present were brook trout (Salvelinus fontinalis), smelt (Osmerus mordax), rainbow trout (Salmo gairdneri), mummichog (Fundulus sp.), eel (Anguilla bostoniensis), stickleback (Pungitius sp.), pumpkinseed (Lepomis gibbosus), and alewife (Pomolobus pseudoharengus). Intensive seining, fyke-net trapping, spot-poisoning, and check of angler creels in subsequent years showed that a complete kill was achieved. This gave a warm-water fish-carrying capacity of 36 pounds per acre.

Detoxification did not occur during the fall in which the reclamation work was done, and it was not until May 1951 that 3,000 brook trout fingerlings (average, 4 inches) and 500 fin-clipped brook trout yearlings (average, 7 inches) were stocked. These trout weighed a total of 122 pounds.

Fishing was prohibited during the 1951 season, although some illegal angling did occur. On the opening day in 1952, most fingerlings had not grown to the 9-inch minimum legal size and the fishing was terminated. About 100 trout were caught; about 80, many of which experienced hooking mortality, had to be returned to the water.

A mark-and-recapture estimate of the trout population was made with seines and fyke traps in October 1952, 18 months after restocking. The estimate indicated the presence of a population of some 1,500 trout (585 pounds). Of these fish, 893 (473 pounds) were caught by anglers in subsequent years. The estimate of 585 pounds represented maximum trout-carrying capacity of the pond, achieved under reclaimed status, and represented 65 percent by weight of the standing crop of warm-water fish estimated to be present at reclamation.

Fishing was permitted in 1953 and thereafter. The trend in other regulations was toward relaxation or abolishment: the use of live bait, except fish in any form, and of boats was legalized in 1953; the open season was extended from 3 to 6 months in 1954; and the retention of any size of trout was permitted in 1955.

Additional stocking occurred in 1955 and 1956 (table 1), and trout stocks were augmented through natural reproduction of brook trout. Angler harvest was assessed by means of an intensive creel census. Maximum angler harvest for the period 1953-56 occurred in 1955 and amounted to 1,124 trout weighing a little more than 400 pounds (table 2).

Early in the spring of 1954 it was reported that children had liberated a few bullheads in the pond and that a sportsman had introduced smelt as forage for the trout. These species spawned successfully that year and in 1955 and 1956. The pond again was treated, and the fish were recovered after the fishing season late in October 1956. Differences between the second and the initial reclamation were: cooler water temperatures prevailed (in 1950: surface, 66°; middle, 60°; bottom, 48°; and in 1956: surface, 57°; middle, 55°; bottom, 45°); the rotenone was pumped instead of being bag-dragged at depths below 30 feet; and the rotenone concentration was increased threefold (to 1.5 p.p.m.). Even so, some bullheads were missed and have since reinfested the pond.

A fish population consisting mostly of smelt and bullheads (roughly 45,000 individuals) and amounting to 43 pounds per acre was recovered (table 3). There was only 117 pounds of trout in the pond, even though 507 pounds of catchable rainbow trout (2,000 fish) had been planted there 5 months before and only 136 pounds (507 fish) had been removed in the interval by anglers. Stocked rainbow trout did not grow (table 4). Brook trout fingerlings stocked the previous year had shown a low survival rate. Obviously, trout-carrying capacity was depressed with the advent and subsequent build-up of competition from the smelt and bullheads.

The abundant small smelt were little used by the trout as food. To determine the food eaten, 506 trout (162 rainbow and 64 brook trout taken by anglers, and 280 rainbows recovered in the reclamation)

TABLE 1.--Yield of trout from Higgins Pond

	Date of planting								Total or average
	May 1951	May 1951	Reproduction 1953	Reproduction 1954	May 1955	September 1955	Reproduction 1956	June 1956	
Species of trout	Brook	Brook	Brook	Brook	Brook	Brook	Brook	Rainbow	
Total number of trout planted	3,000	500	-----	-----	2,300	2,000	----------	2,000	9,800
Average size (inches)	4.0	7.0	-----	-----	5.0	2.5	----------	8.5	-------
Total pounds	79	43	-----	-----	117	13	----------	507	759
Angler harvest:									
[1]/ 1952	-----	20	-----	-----	-----	---------	----------	-------	20
1953	100	104	-----	-----	-----	---------	----------	-------	204
1954	650	-----	100	-----	-----	---------	----------	-------	750
1955	19	-----	162	-----	943	---------	----------	-------	1,124
1956	-----	-----	-----	21	194	---------	----------	584	799
Total:									
Number	769	124	262	21	1,137	---------	----------	584	[2]/ 2,897
Percentage	26	25	-----	-----	49	---------	----------	29	[2]/ 27
Pounds	404.0	69.2	113.0	14.0	445.4	---------	----------	135.7	1,181.3
Number removed by sampling	34	-----	-----	31	-----	---------	----------	-------	65
Pounds removed by sampling	17.0	-----	-----	7.3	-----	---------	----------	-------	24.3
Number of trout found at reclamation	-----	-----	-----	-----	-----	1	108	451	560
Pounds of trout found at reclamation	-----	-----	-----	-----	-----	0.3	4.3	112.4	117.0
Total number of trout accounted for	803	124	262	52	1,137	1	108	1,035	3,522
Total pounds of all trout accounted for	421.0	69.2	113.0	21.3	445.4	0.3	4.3	248.1	1,322.5

[1]/ Opened to angling on April 15 only.

[2]/ Natural reproduction not included.

TABLE 2.--Creel census data for Higgins Pond for the period 1952-56

	1952	1953	1954	1955	1956
Total angler days	100	638	1,500	1,075	1,330
Angling hours per acre	8	39.9	225	121	170
Total number of trout harvested	20	204	750	1,124	799
Total pounds of trout harvested	6.0	103.7	375.0	404.5	281.1
Number of trout caught per hour	1/ 0.10	0.25	1/ 0.17	0.37	0.19
Number of trout caught per acre	0.8	8.0	37.5	44.9	32
Pounds of trout caught per acre	0.2	4.1	15.0	16.2	11.2
Average length of trout caught (inches)	9.3	10.4	10.3	10.6	9.5
Average weight of trout caught (pounds)	0.30	0.5	0.5	0.36	0.35

1/ Includes only trout that were harvested. In 1952, approximately 80 additional brook trout (7 to 9 inches in length) were caught but released; many of these died of angling injuries. In 1954, approximately 350 additional 6- to 10-inch brook trout were caught but released.

TABLE 3.--Fish recovered from Higgins Pond when reclaimed in 1950 and 1956

Species	Number	Average size (inches)	Size range (inches)	Weight (pounds)	Percent of total
		September 19, 1950			
Brown bullhead	979	6.3	1 - 11	142.1	17.0
Golden shiner	8,325	3.9	2 - 7	244.5	30.0
Killifish	9,365	----------	----------	164.3	20.0
Mummichog	25	3.0	----------	tr.	tr.
Chain pickerel	18	14.7	7 - 23	22.5	3.0
Yellow perch	7,139	4.7	2 - 16	247.4	30.0
Total	25,837			820.8	100.0
Standing crop: 33 pounds per acre.					
		October 22, 1956			
Brown bullhead	17,912	3.5	1 - 11	542.8	51.0
Smelt	26,825	3.5	1 - 8	412.7	38.0
Mummichog 1/	101	3.0	----------	1.5	tr.
Eel 1/	1	19.0	----------	.5	tr.
Killifish 1/	1	3.5	----------	tr.	tr.
Stickleback 1/	19	1.5	----------	tr.	tr.
Rainbow trout	451	8.5	7 - 13	112.4	10.5
Brook trout	109	5.5	3 - 9	4.6	.5
Total	45,419			1,074.5	100.0
Standing crop: 43 pounds per acre.					

1/ Undoubtedly introduced via the weeds used to pack salt-water shrimp, which are used extensively in the area as bait. These weeds often contain the larvae and young of the species noted.

TABLE 4.--Average growth, in inches, of trout in Higgins Pond

/Data obtained principally from fish taken by angling. Average lengths of the fish at the time they were stocked are shown in parentheses./

Age of fish		April 28, 1951	April 28, 1951	Reproduction		May 6, 1955	Reproduction 1956	June 14, 1956
Years	Months	Brook	Brook	1953 Brook	1954 Brook	Brook	Brook	Rainbow
0	4	---	---	1.5	---	---	---	---
	5	(4.0)	---	2.0	2.0	(5.0)	---	8.5
	7	---	---	---	4.0	---	---	---
	9	---	---	---	5.9	---	---	---
	10	7.4	---	7.2	---	9.3	5.1	8.5
1	4	7.9	(7.0)	9.0	---	---	---	---
	5	---	---	---	---	12.2	---	---
	6	---	---	10.1	---	---	---	---
	7	---	---	---	---	14.1	---	---
	10	10.1	9.0	---	---	---	---	---
2	4	10.7	9.3	11.6	11.3	---	---	---
	10	---	11.7	---	---	---	---	---
3	4	13.4	13.2	---	---	---	---	---

were examined. Only 30 were found to contain fish remains. (Freshly ingested smelt in the stomachs of trout taken in the reclamation were omitted in the assessment.) Insects and leeches constituted the major food items found in all the trout stomachs containing food. Trout using fish as food were limited, for the most part, to individuals ranging between 12 and 18 inches in length. Trout 12 to 15 inches long were relatively common between 1953 and 1954. The biggest trout produced was a 3-pound, 18-inch brook. However, the real potential of the pond appeared to lie in the production of 10-inch trout.

Hathaway Pond, Barnstable, Massachusetts

This is another landlocked Cape Cod pond. It has a surface area of 20 acres, a maximum depth of 57 feet, and an average depth of 23 feet. The summertime layer of trout water generally lies between 34 and 56 feet and forms 14 percent of the water volume. About 5 acres of pond bottom is exposed to the trout water zone. Water transparency is 24 feet. Methyl orange alkalinity in August runs from 9.0 p.p.m. at the surface to 11.0 p.p.m. at the bottom. The pH ranges between 6.5 and 6.3.

Reclamation was undertaken in September 1952.[1] Powdered rotenone was used at a concentration of 0.5 p.p.m., bag-dragged through the depths for maximum dispersal. Approximately 857 pounds of fish, or 43 pounds per acre, was recovered. These fish consisted largely of stunted yellow perch, pumpkinseed, brown bullhead, and killifish (table 5).

Restocking and subsequent maintenance stockings were effected with fingerling rainbow and brook trout (table 6). Estimates of angler harvest were secured through various creel-sampling procedures. Angling was prohibited in 1953 and was permitted thereafter with the

[1] The project was sponsored and financed by the Barnstable Sportsmen's Club, which received technical advice and assistance from the Division of Fisheries and Game.

TABLE 5.--Fish recovered from Hathaway Pond when reclaimed in 1952 and 1956

Species	Number	Average size (inches)	Size range (inches)	Weight (pounds)	Percent of total
		September 27, 1952			
Brown bullhead	1,137	6.8	2 - 11	264.0	31
Eel	8	40.0	37 - 45	40.0	5
Goldfish	2	----------	----------	6.0	1
Killifish	25,000	----------	----------	250.0	29
Pumpkinseed	4,500	3.2	1 - 5	80.0	9
Smallmouth bass	1	12.9	----------	1.1	tr.
Yellow perch	7,500	4.3	2 - 14	216.0	25
Total	38,148			857.1	100
Standing crop: 43 pounds per acre.					
		October 29, 1956			
Rainbow trout	176	10.5	7 - 18	65.5	14
Brook trout	57	6.7	4 - 9	6.5	2
Mummichog	1	----------	----------	tr.	tr.
Yellow perch	2	12.0	----------	1.7	tr.
Alewife	90,050	2.5	1 - 4	411.0	85
Total	90,286			484.7	100
Standing crop: 24 pounds per acre.					

same regulations in effect as prevailed at Higgins Pond for these years (1954-56).

The maximum annual angler harvest amounted to 457 trout weighing approximately 240 pounds (table 7). At the close of the 1956 fishing season, the pond was re-reclaimed and the fish population recovered as in the original reclamation. This produced an additional 233 brook and rainbow trout weighing 72 pounds (table 6). The combined production suggests a trout-carrying capacity, in this instance, of 20 to 40 percent of the standing crop of warm-water fish recovered in the original reclamation.

Mortality of stocked fingerlings was evidently the major limiting factor encountered in management of this pond. Restocking was done in February 1953 with 1,350 rainbow trout fingerlings (average, 3.5 inches). The first check on the growth of these fish was made in October of the same year. At that time, the fish averaged 11.5 inches; but population density appeared low, as only 5 percent of this stocking was included in the angler harvest.

The factors responsible for this abnormal mortality were not uncovered, but certain observations relative to the problem were made. From a State hatchery 150 miles distant, 1,500 rainbow trout averaging 1 inch in length were transported to Hathaway Pond in May 1954. One thousand were stocked; the remaining 500 were placed in a nearby hatchery for observation. Initially, the 500 showed no ill effects from the trip; the following day, all were dead. It was assumed that all the pond-planted fry died, likewise. This was later verified through creel checks and other sampling procedures. Apparently the same fate befell yet another stocking of 1,500 rainbow trout (1.5 inches long) planted in April 1955 (table 6). Two plants of 500 brook trout of similar size stocked in June 1954 and April 1955 gave angler returns of 25 and 31 percent, respectively. One fall plant of 300 larger brook trout fingerlings (average, 3.7 inches) yielded a

TABLE 6.--Yield of trout from Hathaway Pond

	Date of planting									Total or average
	Feb. 1953	May 1954	June 1954	Oct. 1954	Nov. 1954	Apr. 1955	Apr. 1955	Oct. 1955	Reproduction 1956	
Species of trout-----	Rainbow	Rainbow	Brook	Brook	Rainbow	Brook	Rainbow	Rainbow	Brook	
Total number of trout planted----------	1,350	1,000	500	300	700	500	1,500	1,000	----------	6,850
Average size (inches)	3.5	1.0	1.0	3.7	5.5	1.5	1.5	4.5	----------	-------
Total pounds---------	22.5	0.5	0.3	6.2	47.0	2.0	6.0	37.0	----------	121.5
Angler harvest:										
1954----------	55	-------	-----	-----	-------	-----	-------	-------	----------	55
1955----------	10	-------	124	52	38	-----	-------	-------	----------	224
1956----------	-------	-------	3	5	219	153	-------	77	----------	457
Total:										
Number----------	65	-------	127	57	257	153	-------	77	----------	736 [1]
Percentage------	5	-------	25	19	37	31	-------	8	----------	11
Pounds----------	76.0	-------	44.0	22.1	176.5	41.3	-------	23.4	----------	383.3
Number removed by sampling----------	1	-------	30	-----	-------	-----	-------	-------	----------	31
Pounds removed by sampling----------	2.5	-------	3.6	-----	-------	-----	-------	-------	----------	6.1
Number of trout found at reclamation----	-------	-------	-----	-----	12	1	-------	164	56	233
Pounds of trout found at reclamation----	-------	-------	-----	-----	18.3	0.3	-------	47.2	6.2	72.0
Total number of trout accounted for-----	66	-------	157	57	269	154	-------	241	56	1,000
Total pounds of trout accounted for-----	78.5	-------	47.6	22.1	194.8	41.6	-------	70.6	6.2	461.4

[1] Natural reproduction not included.

return of 19 percent, or slightly less than that of the foregoing; yet 38 and 24 percent of two fall plants of relatively large (5.5- and 4.5-inch) rainbow trout fingerlings were accounted for as catchable-size fish (table 6).

Fingerling growth varied considerably in the different plants. Maximum growth gain was made by survivors of the initial rainbow stocking when fish population density was lowest. It was poorest for the rainbow trout planted in the fall of 1955 and exposed to maximum fish population density attained by the pond under reclaimed status (table 8). The progeny of 100 adult sea-run alewives stocked in the spring of 1956 contributed to this latter population density.

These alewives were stocked experimentally as forage for the trout. Some 90,000 alewives, weighing 411 pounds, were estimated to be present at the second reclamation (table 5). Average size was 2.5 inches. Even so, only 26 from a total of 265 trout examined contained alewives or their remains. These trout were all at least 8 inches long. Again, as at Higgins Pond, only the larger trout were found to have eaten the alewives, and the principal fare of all trout consisted of insects and leeches.

TABLE 7.--Creel census data for Hathaway Pond for the period 1954-56

	1954	1955	1956
Total angler days	900	662	1,497
Angler hours per acre	87	66.2	194
Total number of trout harvested	55	224	457
Total pounds of trout harvested	55	89.6	239.5
Number of trout caught per hour	0.03	0.17	0.11
Number of trout caught per acre	2.8	11.2	23
Pounds of trout caught per acre	2.8	4.5	12.0
Average length of trout caught (inches)	13.8	10.0	10.6
Average weight of trout caught (pounds)	1.0	0.4	0.5

TABLE 8.--Average growth, in inches, of trout in Hathaway Pond

/Data obtained principally from fish taken by angling. Average lengths of the fish at the time they were stocked are shown in parentheses./

Age of fish		February 1953	June 7, 1954	Oct. 27, 1954	Nov. 5, 1954	Apr. 29, 1955	Oct. 26, 1955	Natural reproduction
Years	Months	Rainbow	Brook	Brook	Rainbow	Brook	Rainbow	Brook
0	4	-------	-------	--------	-------	(1.5)	--------	----------
	5	-------	-------	--------	-------	--------	--------	3.0
	6	-------	(1.0)	--------	-------	--------	--------	----------
	9	-------	6.0	--------	-------	--------	--------	----------
	10	-------	-------	(3.7)	(5.5)	--------	(4.5)	6.7
1	2	(3.5)	-------	--------	-------	--------	--------	----------
	4	-------	10.3	6.2	8.7	8.9	7.0	----------
	9	-------	-------	10.2	11.2	--------	--------	----------
	10	11.5	-------	--------	-------	--------	9.7	----------
2	4	13.9	13.7	11.5	12.3	--------	--------	----------
	7	-------	-------	--------	13.9	--------	--------	----------
	9	16.3	-------	--------	15.9	--------	--------	----------
	10	-------	-------	--------	16.4	--------	--------	----------
3	4	20.1	-------	--------	-------	--------	--------	----------

An attempt in 1953 to transfer the landlocked small alewife found in New Jersey failed here.

Of interest, too, is the fact that the second reclamation revealed the presence of 56 naturally produced brook trout and two 12-inch yellow perch (table 6). The yellow perch consisted of a male and a female. One can only speculate on what the future would have held for this species if death had not intervened. They were reported to have been stocked by children the previous June. Scale readings indicated that these perch were 5 years old and averaged 7 inches at that time.

North Pond, Florida, Massachusetts

This pond is located in the relatively infertile Berkshire Hills region of western Massachusetts at an elevation of 1,924 feet. In common with the other waters described in this paper, North Pond is readily accessible, even though relatively remote from metropolitan areas. It has a surface area of 18 acres, a maximum depth of 28 feet, and an average depth of 13 feet. It has an outlet but no inlet. The summertime layer of trout water generally lies between 17 and 27 feet and constitutes 14 percent of the water volume. About 5 acres of bottom area is exposed to this trout-water layer. Water transparency is 19 feet. The pH ranges between 6.8 at the surface and 5.8 on the bottom.

Reclamation was undertaken in October 1951 with powdered rotenone at a concentration of 0.5 to 1 p.p.m. About 731 pounds of warm-water fish, or 41 pounds per acre, was killed and recovered. The fish consisted mostly of stunted yellow perch, golden shiners, brown bullheads, and a few large chain pickerel. The pond was restocked in April 1952 with 3,500 brook trout that were closely graded to 6 inches and weighed 270 pounds. All fishing was prohibited.

A mark-and-recapture estimate of the trout population was made the following November with seines. More than 600 trout were involved and the ratio of the marked to unmarked fish was high, lending credence to the estimate obtained. It indicated a population consisting of 2,925 trout weighing 651 pounds and ranging from 6.5 to 9.5 inches in length. Most were just under the minimum legal length of 9 inches. Because of this, fishing was not allowed during 1953. Another population estimate indicated that only 523 trout were present in the fall of 1953. At this time the fish were 8 to 11 inches long. The magnitude of the mortality involved was difficult to accept, especially in light of the slow growth. However, it was substantiated by a harvest of only 350 to 400 similar-sized trout in the following spring when the pond was opened to angling. Extensive spot-poisoning checks after this harvest, which occurred during the first few weeks of the open season, revealed that the pond was devoid of fish.

Concentrations of trout were observed at the outlet during the spawning season in 1953. It was reported that trout too large for the small outlet stream to have produced naturally were caught there. If the brook trout did migrate to the outlet for spawning, the presence of a precipitous cascade undoubtedly prevented reentrance to the pond. Therefore, it is concluded that the loss experienced was due to downstream movement or to death from old age of this short-lived species, or both.

The history of North Pond since 1954 is fragmentary. The pond has been stocked annually with 2,500 to 3,000 fingerling brook, brown, and rainbow trout. These plants generally have consisted of 2- to 5-inch fall fingerlings, although spring planting of brook trout fry was tried in 1954 and 1955. The success and growth of these plants have been good, judging from limited sampling of anglers' creels. As an example, 63 anglers were checked on 7 different occasions in the fall of 1955. Their catch consisted of 171 trout, 6 to 16 inches in length, for 191 hours of angling effort. These fish had grown from fingerling size at an average rate of about 0.75 inch per month. Apparently, fishing of similar quality has been the rule, with the inevitable slumps and peaks characteristic of any fishery. The outlet was screened in 1954; and no detectable abnormal loss of adult trout, owing to downstream migration

or factors other than angler harvest, has been noted since. No reproduction of trout is known to have occurred. All evidence indicates that trout are the only fish species present 7 years after reclamation.

Appraisal of the mark-and-recapture population in November 1952 indicated a trout-carrying capacity equal, by weight, to 90 percent of the warm-water fish recovered at reclamation. Whether this trout-carrying level was ever attained after 1954 is not known. However, there is some fairly reliable information on how trout production in the absence of competition compared with that attained under conditions of competition with warm-water fish or "two-story" management.

Five thousand 5- to 6-inch brook trout were stocked in November 1934, and 1,135 8- to 10-inch brook trout were stocked in November 1935. The pond was closed to fishing during these years. Netting records for this period indicate a warm-water fish population complex similar to that found at reclamation in 1951. Angler-harvest records were tabulated by the Civilian Conservation Corps under a permit system in 1936, when fishing was allowed. Presumably, the pond was at a maximum trout-carrying capacity when opened to fishing. Numbers and sizes of trout stocked were ample to seed the environment. Sufficient time had elapsed between stocking and harvest to allow for maximum growth gain but was not excessive in relation to the natural life expectancy of the fish. Angler harvest for the year 1936 totaled 915 trout, weighing 229 pounds. Undoubtedly, all trout present were not caught; but the character of the fishing suggests that not many trout went uncaught. More than 90 percent of the catch was recorded in the first 2 days of the season, even though 60 percent of the fishing pressure occurred later in the season. Assumption of a 70-percent harvest of available trout (believed conservative in that the harvest pattern paralleled that recorded in 1954) brings the estimate of total trout present up to about 1,300 fish weighing 327 pounds. This equals a trout-carrying capacity of less than half that under reclaimed status, or about 45 percent of the carrying capacity for warm-water fish.

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CONTROL OF AQUATIC INSECTS WITH VEGETABLE OILS

Dr. S. W. Ling, inland-fishery expert for the Food and Agricultural Organization of the United Nations, on temporary assignment to the Bureau of Sport Fisheries and Wildlife, has noted that predaceous aquatic insects are a problem at many warm-water fish-cultural stations in the South. The same problem exists in fry ponds in southeast Asia.

In the United States, the practice has been to use as much as 3 gallons of a mixture of old motor oil and gasoline on a 1-acre pond to control backswimmers. Dr. Ling believes that the Asian method of applying an emulsion of vegetable oil at a rate of about 1.5 gallons per acre would be as cheap and probably more effective for insect control and would have less residual effect on the young fish.

The unrefined vegetable oils are mixed with a small amount of liquid crude soap to increase the spreading capacity and then stirred vigorously to form the emulsion. This is sprayed from the pond banks, and one treatment usually is sufficient to control the insects during the period during which fry grow to fingerling size--the period when they are most vulnerable.

AN UNDERWATER OBSERVATION CHAMBER

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THE ENUMERATION OF FISHES MIGRATING UPSTREAM is a major concern of management and research. It provides an index of the effectiveness of regulation and conservation measures. In recent years considerable attention has been given to the development of automatic fish-counting systems to meet rising labor costs, to provide more data of known accuracy, and to provide continuous passage for the fish. A Lethlean-type fish counter (Lethlean 1953), built in Seattle, would count fish but would not identify species. Accordingly, it was made to trigger a subsurface camera which had to be located adjacent to the tunnel exit.

The turbidity of the water was a problem that could be reduced only by having all the space between the camera lens and the closer edge of the depth of focus perfectly transparent. The camera with a 3-foot minimum focus required a large window to photograph large fish passing close by. An underwater housing for camera and lighting equipment combined with an underwater observatory was desired in order to facilitate the inspection and study of the behavior of fish emerging from the tunnel.

Thus a submerged chamber with a large window appeared to be the solution to the problem. This chamber had to be movable, easily constructed, relatively inexpensive, and capable of being placed close to a fishway wall. Donaldson's all-metal device (Hanson, Zimmer, and Donaldson, 1950: 10-11) would have been adequate except for the small window area and large base.

The chamber described here was designed and built for use at the fish ladder by the Hiram M. Chittenden Locks in Seattle, Washington (figure 1). Although this device was constructed as an aid in fish-counter research and development, it has many additional uses. In and around fishways, it can be used to observe the behavior of fish at submerged orifices, in the pools, and in collection systems. In streams, ponds, lakes, and lagoons, it would be useful in the observation of spawning, courtship, nest building, and other activities of interest to the fish-culturist and aquatic biologist.

Description and Fabrication

The device consists of a standard 8-foot length of reinforced concrete pipe with 3.5-inch walls and a 30-inch inside diameter (figure 2). A projecting tube of similar diameter near the lower end is terminated by a vertical window. Near the top of the pipe are four 0.75-inch boltholes reinforced with inverted U-shaped supports in the concrete. The cylinder hangs from the bolts by four 4- by 0.25-inch steel straps welded to a steel angle frame at the top. A 16-gauge galvanized sheet steel splash guard extends up 31 inches from the bolts to the top of the frame. Frame flanges are 5 inches horizontal, 3 inches vertical, and 0.25 inch thick. A mastic-type glue, rubber and steel washers, and oakum are used to keep the boltholes watertight. The nuts and washers are placed on the inside to facilitate adjustment, inspection, and

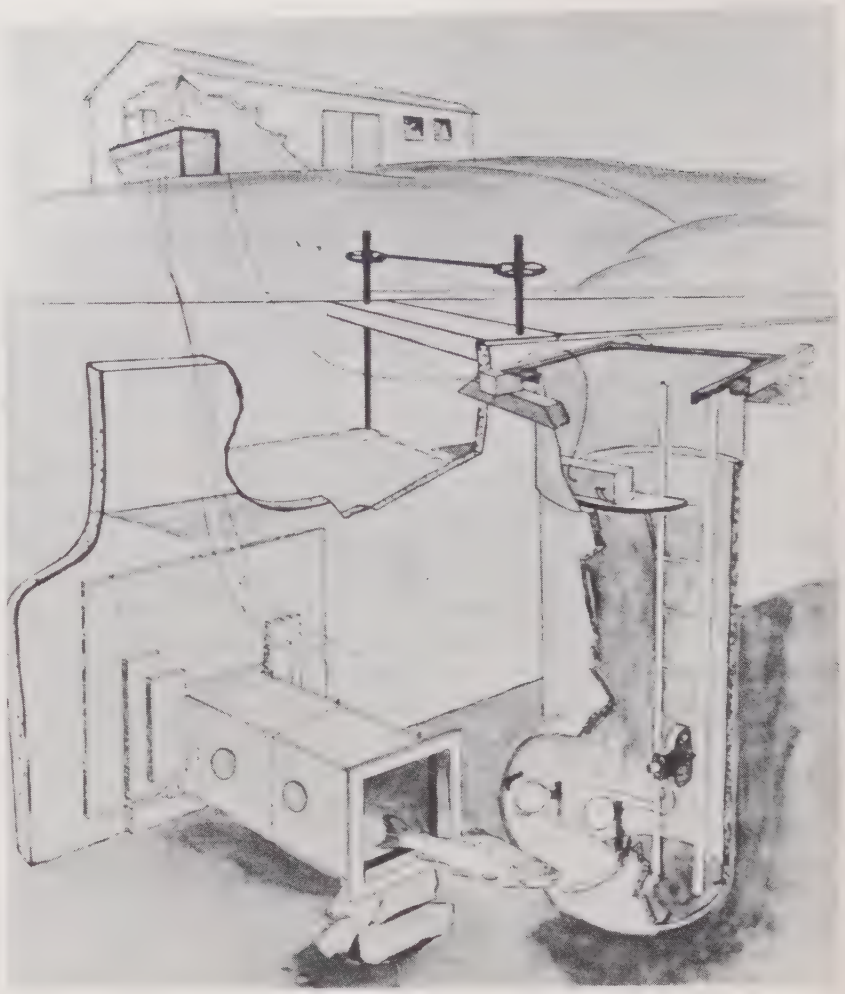

FIGURE 1.-- Drawing of the observation chamber in use. Wires extend from counting tunnel to the counter in laboratory building, and from the counter to controls, lights, and camera in chamber.

replacement. Leakage between the splash guard and concrete is stopped by use of mastic glue and oakum. The concrete exterior is waterproofed by an asphalt compound prepared for cellar-wall exteriors.

The methyl methacrylate[1/] window, 1 inch thick, provides the required six-ton-one safety factor for an 8-foot depth. This factor is required for the safety of the observer. The diameter of the plastic sheet is 32 inches, which allows a 1-inch overlap all the way around. Clearance is allowed around the edge to take care of expansion. (Glass absolutely should not be used unless the added hardness is required, and then only after several manufacturers' engineers have been consulted and the strength has been calculated and carefully checked. At the pressure and depth involved, breaking of the glass could be fatal.) The circular plastic plate is held against 1.25-inch soft rubber gasket by the mastic glue and water pressure (2,000 pounds). A 0.25-inch steel circular plate at the bottom is secured in the same manner.

The observatory weighs 3,900 pounds and has a buoyant force of 4,300 pounds in water to the bolt line. Weight may be added after the chamber has been partially submerged. (The total weight must exceed the buoyant force for the maximum expected head.) The added weight, including observers, should not exceed one-fourth of the hydrostatic force on the bottom. There are other alternatives, such as using metallic or heavy sand in the concrete or weights cemented into the bottom. In any event, it is advisable to prepare a buoyancy chart (figure 3). The addition of 700 pounds of weights to the inside of the bottom lowers the center of gravity to about 5.7 inches below the center of buoyancy and makes the device stable. The total hydrostatic force pushing up on the bottom steel plate is about 2,700 pounds when the water is at the bolt line.

[1/] Methyl methacrylate is sold under a number of trade names in the United States. The harder, heat-resistant type of methyl methacrylate has been used for this window.

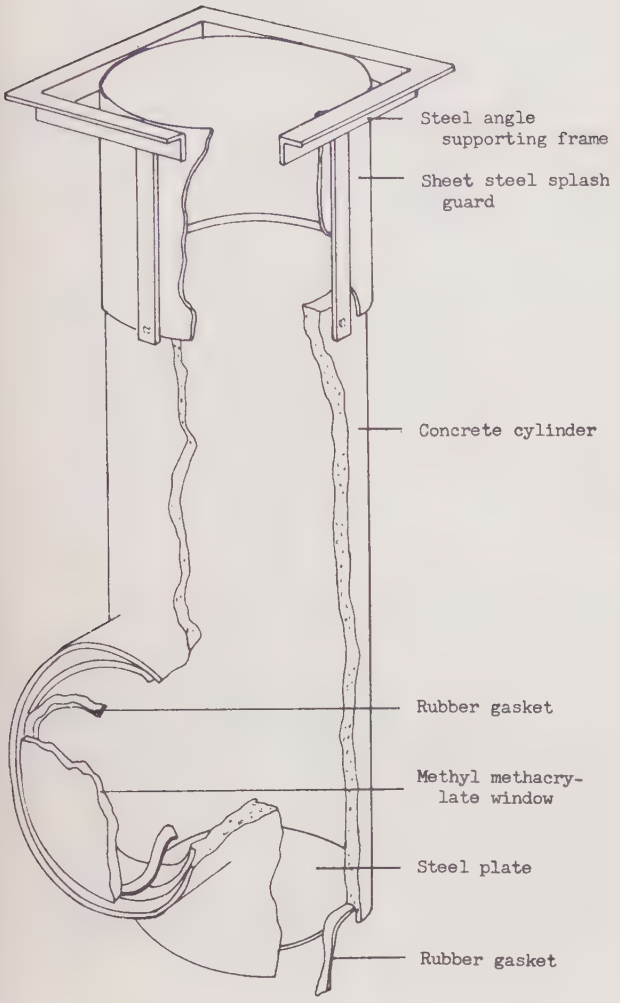

FIGURE 2.--A cutaway view of the underwater observation chamber.

Operation and Use

When the chamber is suspended, as this one is, wave action must be considered. Waves of sufficient magnitude and resonant frequency would necessitate bottom anchoring, but a 4- to 6-inch sway at the bottom has caused no structural defects.

Originally wood beams supported the angle frame. Sandbags on each corner satisfactorily reduced swaying. Later, these bags were replaced by steel I-beams to which the frame was bolted. The I-beams required less maintenance and were adequately flexible (16-inch web, 7-inch flange).

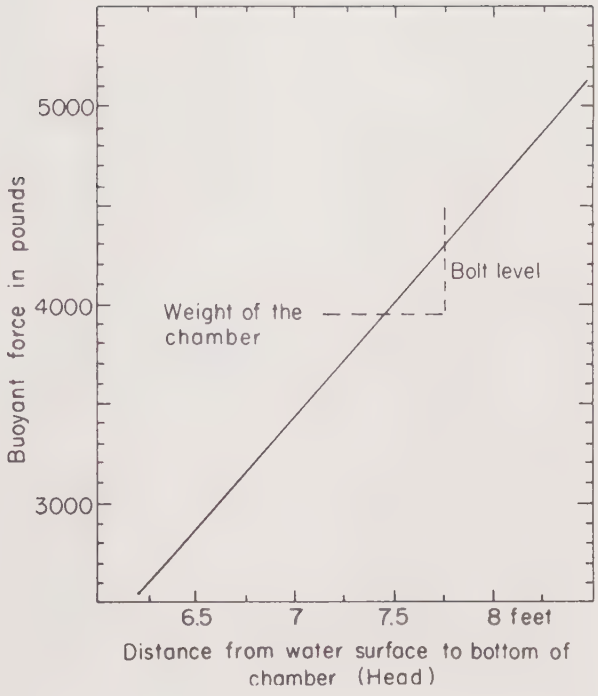

FIGURE 3.--Buoyancy chart.

When handling the chamber out of water, we rested it on a soft wood pad to avoid chipping the lower rim. The inside weights should be removed while lifting the chamber from the water.

In use, the chamber has been satisfactory. A ladder of aluminum angle hooked to the top of the splash guard provides access. A man of average size can sit comfortably in front of the window if the weights have been properly distributed. The distance from the inside of the window to the opposite wall is 41 inches. Thus, a camera secured to the ladder could have the outside of the window in depth of focus. Electronic flash bulbs placed on the inside of the window illuminated passing fish, in connection with preliminary photographic experiments. The results were fair even in slightly turbid water.

Maintenance

Maintenance is simple. In 4 years of use, the only leaks occurred at the

boltholes and at the junction of the splash guards and concrete. These leaks were easily stopped.

The outside of the window has been cleaned with a long-handled push broom covered with a towel. Care must be taken to avoid scratching the plastic.

Acknowledgment

The authors appreciated the help of S. D. Campbell of the Foss Launch and Tug Company, whose generosity made the installation possible.

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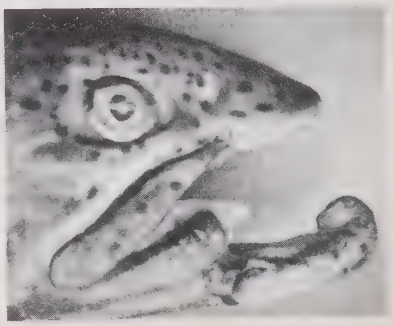
JAW TAGS AND SEXUAL DIMORPHISM IN MATURE RAINBOW TROUT

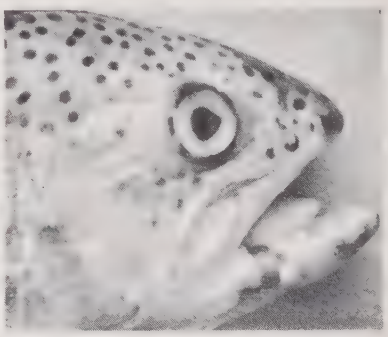
Monel-metal jaw (band) tags were put on rainbow trout in October 1955. Effects of the tags over a 9.5-month period were reported in 1957 (THE PROGRESSIVE FISH-CULTURIST 19 (2): 67). As the trout were held for 3 years, however, there was opportunity to observe that the condition of the tagged fish varied in magnitude with sexual development as well as length of time and holding conditions.

In all males exhibiting secondary sexual characters such as lengthening and thickening of the jaw toward the snout, the tag became wholly embedded in the mandible and the enlarged, elongated right lower jaw was fractured and torn. For their length, the tagged males were significantly lighter than untagged males of the same age class, a condition suggesting impaired ability to feed. As growth condition factors and reproduction potential may be rated partly as functions of feeding, it may be assumed that tags caused ill effects. It is not suggested here that all jaw tags are harmful to all fish, but the apparent influence on feeding and availability for capture should not be overlooked if tags are used in long-range studies of fish populations exhibiting sexual dimorphism.

The mandibles of mature tagged females were in no way unusual: typical thick infolding skin, without erosion, protected the jaw bone. Weights of tagged and untagged females were similar, indicating that tags did not inhibit active feeding.



The head of a tagged male rainbow trout measuring 53.34 centimeters. The jaw bone of this fish is fractured.



The head of a tagged female rainbow trout, 56.88 centimeters long. This shows a normal tag.

---BERNARD W. CORSON, New Hampshire Fish & Game Department, Concord.

COST OF DISEASE TREATMENT

Robert G. Piper and Ken Wolf
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Eastern Fish Disease Laboratory, Leetown Station, Kearneysville, West Virginia

IN DIAGNOSTIC WORK THE QUESTION OFTEN ASKED is, "How much is it going to cost to treat these fish?" The data presented here make possible a uniform answer to this question, in that with them one can quickly and easily determine the cost of drugs used for treating any known weight of fish, for any length of time, with any orally administered antimicrobial agent.

Table 1 has been prepared to furnish values for the most commonly used dosages. It also has a wide range of whole numbers, so that intermediate values accurate to 0.5 cent and 0.5-gram dosage rates can easily be determined by addition. For example, sulfonamides are routinely administered at the rate of 8 grams per 100 pounds of fish per day. The cost of treating 1,000 pounds of fish for 1 day is determined in the following way. If the cost of the sulfonamide is 3.5 cents per gram, two dosage values (left-hand column) are taken from table 1:

8 grams/100 pounds/day at
3 cents/gram = $2.40
0.5 cent/gram = .40.

Therefore, the total cost of treating 1,000 pounds of fish for 1 day is $2.80. This value is then multiplied by the number of days recommended for treatment[1/] and by the number of thousands of pounds in the particular lot.

As many publications on diseases of fish give dosages in terms of milligrams per kilogram of fish, several of the most common conversions of kilograms to pounds are provided with table 1.

Antibiotics, nitrofurans, sulfonamides, and other such agents are often available in technical grades. These agents are not usually the sterile, highly refined product demanded for human use; and they are proportionally less expensive. Several drugs commonly used in treatment of fish diseases are available in poultry- or veterinary-type formulations. These formulations are mixtures of a drug and inert ingredients. Care must be exercised in determining the amount of substance to use, because only the drug itself is considered. Similarly, for the purposes of using this table, the cost is based on only the drug contents. For example, a pound of one such poultry formula contains only 25 grams of antibiotic and sells for about $4. The real drug cost is, therefore, 16 cents per gram.

Standard minimum treatments with the most commonly used antimicrobial drugs are summarized in table 2. Average current prices in the eastern United States are also given.

(THE PROGRESSIVE FISH-CULTURIST 19 (2): 51-57)

[1/] The computation also reveals the relative cost of treatment. If, as Tunison found, the average cost of federally produced fish is $1 per pound, a hypothetical 10-day course of sulfonamide costs $28, or 2.8 percent of the fishes' value.

Mr. Piper's present address: U. S. Fish-Cultural Station, Box 862, LaCrosse, Wisc.

TABLE 1.--Cost of drugs required to treat 1,000 pounds of fish for 1 day

/Values for the most commonly used dosages are underlined./

Rate of dosage (grams per 100 pounds of fish per day)	Cost per gram of drug used							
	0.5 cent	1 cent	2 cents	3 cents	4 cents	5 cents	10 cents	20 cents
0.5	$0.025	$0.05	$0.10	$0.15	$0.20	$0.25	$ 0.50	$ 1.00
1.0	.05	.10	.20	.30	.40	.50	1.00	2.00
1.2	.06	.12	.24	.36	.48	.60	1.20	2.40
2.0	.10	.20	.40	.60	.80	1.00	2.00	4.00
2.3	.12	.24	.48	.72	.96	1.20	2.40	4.80
3.0	.15	.30	.60	.90	1.20	1.50	3.00	6.00
3.4	.17	.34	.68	1.02	1.36	1.70	3.40	6.80
4.0	.20	.40	.80	1.20	1.60	2.00	4.00	8.00
4.5	.23	.45	.90	1.35	1.80	2.25	4.50	9.00
5.0	.25	.50	1.00	1.50	2.00	2.50	5.00	10.00
6.0	.30	.60	1.20	1.80	2.40	3.00	6.00	12.00
7.0	.35	.70	1.40	2.10	2.80	3.50	7.00	14.00
8.0	.40	.80	1.60	2.40	3.20	4.00	8.00	16.00
9.0	.45	.90	1.80	2.70	3.60	4.50	9.00	18.00
10.0	.50	1.00	2.00	3.00	4.00	5.00	10.00	20.00

Rate of dosage (grams per 100 pounds of fish per day)	30 cents	40 cents	50 cents	60 cents	70 cents	80 cents	90 cents
0.5	$ 1.50	$ 2.00	$ 2.50	$ 3.00	$ 3.50	$ 4.00	$ 4.50
1.0	3.00	4.00	5.00	6.00	7.00	8.00	9.00
1.2	3.60	4.80	6.00	7.20	8.40	9.60	10.80
2.0	6.00	8.00	10.00	12.00	14.00	16.00	18.00
2.3	7.20	9.60	12.00	14.40	16.80	19.20	21.60
3.0	9.00	12.00	15.00	18.00	21.00	24.00	27.00
3.4	10.20	13.60	17.00	20.40	23.80	27.20	30.60
4.0	12.00	16.00	20.00	24.00	28.00	32.00	36.00
4.5	13.50	18.00	22.50	27.00	31.50	36.00	40.50
5.0	15.00	20.00	25.00	30.00	35.00	40.00	45.00
6.0	18.00	24.00	30.00	36.00	42.00	48.00	54.00
7.0	21.00	28.00	35.00	42.00	49.00	56.00	63.00
8.0	24.00	32.00	40.00	48.00	56.00	64.00	72.00
9.0	27.00	36.00	45.00	54.00	63.00	72.00	81.00
10.0	30.00	40.00	50.00	60.00	70.00	80.00	90.00

Conversions:

454 grams = 1 pound.
28.4 grams = 1 ounce.

Dosage of 25 milligrams per kilogram per day = 1.2 grams per 100 pounds per day.
Dosage of 50 milligrams per kilogram per day = 2.3 grams per 100 pounds per day.
Dosage of 75 milligrams per kilogram per day = 3.4 grams per 100 pounds per day.
Dosage of 100 milligrams per kilogram per day = 4.5 grams per 100 pounds per day.
Dosage of 200 milligrams per kilogram per day = 9 grams per 100 pounds per day.

TABLE 2.--Standard treatments of various drugs, with approximate 1958 cost and duration of treatment

Drugs	Recommended dosage per 100 pounds fish (grams)	Minimum period of treatment recommended[1] (days)	Approximate 1958 cost per gram
Antibiotics:			
Chloramphenicol	2.3 - 3.5	7	[2] $0.75
Oxytetracycline			.30
Erythromycin	4.5	[3] 21	.15
Nitrofurans:			
Furazolidone	4.5	----------	.10
Sulfonamides:			
Sulfamerazine	8 - 10	10	.035
Sulfisoxizole			

[1] Use of drugs for shorter term treatment or for prolonged preventive treatments at lower rates is not recommended.

[2] If purchased directly from manufacturer in lots of at least 100 grams.

[3] Kidney disease therapy.

ELECTRICAL FISH DIVERSION SCREEN IN ENGLAND

To reduce the annual kill of sea trout and salmon, an electric screen has been installed about 1 mile above the Low Wood Power Station on the River Leven.

Designed for use in a normal water depth of 2.5 feet and also when tidal influence raises the water level below the turbines to 7 feet, the screen is a steel bridge from which are hung sixty 2-inch steel tubes graded to the river banks and bottom and loaded with 3-phase alternating current at 25 volts per phase at 50 cycles. The current consumption of each phase is about 1.5 amperes at low water, 2.3 amperes at high water; thus the total consumption is from 4.5 to 6.9 amperes.

In tests of the installation, salmon kelts in wood boxes seemed comfortable 5 feet downstream from the screen but were uncomfortable when put within 3 feet of it.

Brown trout (0.75-inch), used in tests to study the effect on migrating smolts, were uncomfortable within 9 inches of the screen. A 15-second stay between electrodes immobilized the fish; they recovered in 15 seconds after removal from the field. Held between electrodes for 1 minute, they did not recover. When freed upstream of the screen to be taken through it by the flow, many were killed, sinking quickly beneath the electrodes.

This first 3-phase alternating-current screen of its type to be set on any river in the country was installed with the cooperation of Mr. Hartley of the Ministry of Agriculture, Fisheries and Food.

--- L. STEWART, Fish. Off., Lancashire River Board, Lancaster, England.

TRAPPING BLUEGILL SUNFISH IN WEST VIRGINIA PONDS

Harvey B. Beall and Richard W. Wahl
Conservation Commission of West Virginia
Charleston, West Virginia

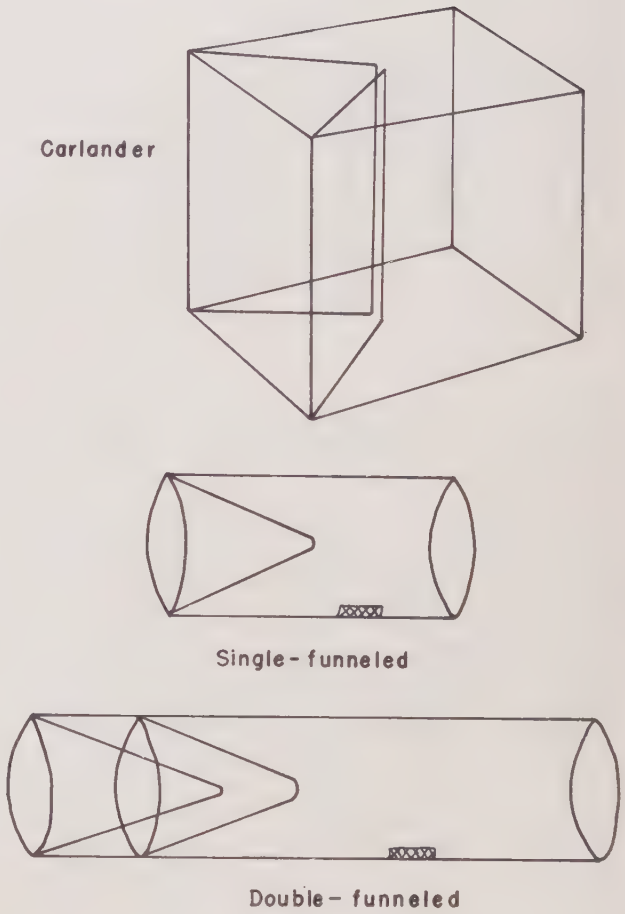
TRAPPING EXPERIMENTS were conducted in some warm-water ponds at the State Fish Hatchery at Palestine, West Virginia, to determine (1) whether traps would be effective in alleviating or preventing overcrowding by bluegills, (2) what kinds of traps would be most effective, (3) whether the addition of wings or leads to a previously tested trap would increase its effectiveness, and (4) whether use of a simple, inexpensive bait would increase the effectiveness of traps.

Techniques

Three general types of traps were used successfully over a 4-year period in several 2-acre ponds at the State warm-water hatchery at Elizabeth, West Virginia. These types were (a) a Carlander trap (PROG. FISH-CULT. 16 (2): 82); (b) cylindrical traps made of inch-mesh chicken-wire; and (c) cylindrical traps made of 0.5-inch mesh hardware cloth (see figure). The general procedure was to fish two or three different traps in proximity to each other and compare the catch of fish over a period of several days or a week.

Carlander Traps

Tests were run on Carlander traps to determine the effectiveness when set with a 15-foot lead, with 15-foot wings, with a brush cover, and without any lead, wings, or disguise. These traps had a throat width of 2.5 inches. Daytime and nighttime effectiveness were also compared.



Drawings of three traps used in fish-trapping experiments in West Virginia farm ponds.

This contribution has been made possible by the Federal Aid in Fish Restoration Act, Project F-3-R, West Virginia.

Cylindrical Traps of Inch-Mesh Chicken Wire

The first two cylindrical traps built and tested were relatively small: 36 inches in overall length and 18 inches in diameter. One trap was fitted with a deep funnel (30 inches long), the other with a shallow funnel (18 inches long). During the experiments these traps were checked daily at 9:00 a.m., all fish were removed, and the catch was recorded.

In one test, a deep-throated cylindrical trap and a Carlander trap were fished in proximity to each other for a 7-day period and the catches were compared.

In another test, a deep-throated cylindrical trap, a shallow-throated cylindrical trap, and a Carlander trap were fished in proximity to each other for a 4-day period and the catches were compared.

Two larger cylindrical traps of inch-mesh chicken-wire were designed after those of Cobb (1954) and are hereafter referred to as Cobb traps. These were 6 feet long and 19 inches in diameter. Each was fitted with two funnels, one inserted at the end and the other 14 inches from the end. The throat of the outer funnel was set at a 5-inch opening, the inner at 4 inches. In order to make it more difficult for bluegills to escape, the throat of one trap was fitted with wooden splints adjusted to a 2-inch opening.

Soybean meal flake and milk curd as baits were compared. These were suspended in mesh bags within the traps.

Double-Funneled Traps of 0.5-Inch Mesh Hardware Cloth

In order to determine the effectiveness of traps in harvesting intermediate-size bluegills (3.0 to 5.4 inches long), two cylindrical traps were constructed of 0.5-inch mesh hardware cloth. Each trap had two funnels, one inserted at the end and the other 14 inches from the end. The outer funnel was 26 inches long and had a 2-inch throat opening; the inner funnel was 24 inches long and had a 4.5-inch throat opening. One trap was 5.5 feet long and 18 inches in diameter; the other was 6 feet long and 20 inches in diameter.

These traps were fished continuously over a 30-day period in October 1957. They were set parallel to each other, about 3 feet apart, in water 3 to 4 feet deep. Each trap was baited with cottage cheese suspended in a 0.25-inch mesh cloth bag near the apex of the inner funnel. At 1- to 5-day intervals, the catch was removed, measured, and weighed in aggregate. After the trapping, the remaining population was inventoried by draining the pond.

Findings

Carlander Traps

The data presented in table 1 show that unaltered Carlander traps were just as effective as traps altered with leads or wings. Covering a trap with brush in order to disguise it apparently reduced its effectiveness.

During a 3-day period when an unaltered trap was being compared with a trap fitted with wings, traps checked at 8:00 p.m. yielded a total of 1,022 small and intermediate-size bluegills, whereas these same traps checked at 8:00 a.m. yielded only 200 bluegills. It would seem that random movement of bluegills (which is assumed to be responsible for their entry into unbaited traps) is much greater during daylight hours than at night.

In addition to the fish captured during the above-mentioned tests, 675 were taken

TABLE 1.--Comparison of number of bluegills caught during several tests of Carlander traps fished in unaltered and altered conditions

Altered condition	Number of trap days	Bluegills caught in unaltered trap	Bluegills caught in altered traps
15-ft. wings	4.5	745	738
15-ft. lead	3.0	70	80
Brush cover	8.0	962	60

during some preliminary work. The total number of fish removed from the 2-acre reservoir, therefore, was 3,771 during a 40-day period. Subsequent draining indicated that these represented 20 percent of the original total number of small and intermediate-size bluegills in the pond.

Carlander Traps vs. Single-Funneled, Inch-Mesh Cylindrical Traps

During 7 days of trapping, a Carlander trap captured 1.87 times as many bluegills as a deep-throated cylindrical trap. In another 4-day test, a Carlander trap captured as many bluegills as two cylindrical traps together.

Carlander Traps vs. Cobb Traps

Results of a 6-day trapping test showed that the use of wooden splints in the throat of a Cobb trap neither increased nor decreased its efficiency when compared with an unaltered trap fished nearby. Two Cobb traps each captured 33 bluegills that weighed 12.5 pounds, while a Carlander trap captured 34 bluegills weighing only 4.2 pounds. The 1-inch chicken-wire used in the Cobb trap would not hold bluegills less than 4 inches in length, whereas the hardware-cloth Carlander trap retained much smaller fish.

During 7 days of trapping with two identical cylindrical traps, sour milk curd appeared to be a better bait than soybean flake. With the milk curd, 45 bluegills weighing 7.4 pounds were taken; whereas with soybean flake, 37 bluegills weighing 5.2 pounds were taken. Cottage cheese was used in later trapping because of its similarity to milk curd and because of its availability. It was found to be highly effective.

Double-Funneled Cylindrical Traps Made of Hardware Cloth

In 30 days of trapping with two cylindrical traps baited with cottage cheese, 1,125 intermediate-size bluegills were removed from a 1.9-acre bass-bluegill pond. The catch averaged about 19 fish per trap-day. Not included in these figures were 478 bluegills, less than 3.0 inches in length, which were returned to the pond.

Table 2 shows the relative success of the two traps. It is interesting to note that whereas the volume of the larger trap was about one-third greater than the volume of the smaller trap, the catch was approximately 10 percent greater in the larger trap.[1/]

Trapping success was noticeably higher during the first half of the month than during the second half. This was attributed, in part, to a drop in temperature during October. During the first 15 days, water temperatures dropped from 74° to 60° F., and in the last 15 days from 60° to 48° F. Total catch of bluegills for the two periods was 885 (79 percent) and 240 (21 percent), respectively. A decrease in the number of bluegills in the pond as

[1/] The trap volumes were computed on the basis of the whole cylinder, ignoring the fact that funnels protrude into the traps.

TABLE 2.--Bluegills of intermediate size caught during 30 days of trapping with double-funneled cylindrical traps baited with cottage cheese

Trap dimensions Length (feet)	Trap dimensions Diameter (inches)	Size range of bluegills (inches)	Total number of bluegills caught	Percent of total number	Total weight (pounds)	Percent of total weight
5.5	18	3.0 - 5.2	515	45.8	20.5	44.5
6.0	20	3.0 - 5.3	610	54.2	25.6	55.5
Totals----------			1,125	100.0	46.1	100.0

a result of trapping might also be expected to reduce trapping success during the month.

The funnel opening 2 inches in diameter did not allow fish more than 5.3 inches long to enter the traps and may have restricted the catch of fish in the upper range of the intermediate category. It seems that an opening 2.25 inches in diameter would be nearer the optimum size for harvesting intermediate-size bluegills.

After trapping operations were completed, the pond was drained and inventoried. Recorded from the pond were 3,237 intermediate-size bluegills weighing 187.8 pounds. A comparison of trapping and inventory data showed that the intermediate-size bluegills had been reduced 25.8 percent in number and 19.7 percent in weight. These figures might have been higher if the trapping had been done earlier in the season.

Summary

It appears that simple wire traps of either the Carlander or cylindrical design are effective in removing bluegills from farm ponds. Alteration of the traps by adding wings or a lead or by covering with brush seems to have no effect on the catch. Cottage cheese suspended in a mesh bag within the trap increases trapping efficiency. Traps selective for intermediate-size bluegills can be constructed by using 0.75-inch mesh hardware cloth and setting the throat opening at about 2.25 inches. By trapping continuously, a pond owner might expect to remove 20 or 30 percent of a bluegill population from a pond in 4 to 6 weeks.

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GENETIC RESISTANCE TO DISEASE IN DOMESTIC ANIMALS

Frederick Bruce Hutt

viii, 198 pp. Comstock Publishing Associates, Ithaca, New York. 1958. $3.50.

It is an old saying that to be healthy and live long, one must have healthy parents. Anyone who has life insurance remembers that the examiner was much more interested in knowing all about the health and longevity of the applicant's ancestors than about his own.

To control diseases of domestic plants and animals, we have several approaches available. We can apply sanitation and keep the pathogens or parasites away. We can immunize animals and thereby increase their resistance to infection. If they become sick, we now have almost an unlimited number of specific drugs and antibiotics to help the infected organism rid itself of the infection. These approaches, except that of immunization, cease to be effective almost as soon as they are stopped. There is, however, one approach that can produce effects of long duration, often lasting through many generations. This is the selection and breeding of disease-resistant plants and animals. Unfortunately, until very recently this most effective way to control infectious diseases had little, if any, application in the control of animal diseases. Therefore, the publication of Dr. Hutt's book is of great importance.

In 9 chapters and less than 200 pages, Dr. Hutt surveys almost all important

diseases of domestic animals from horses and cattle to poultry and honeybees. Even oysters are discussed. Fish are missing, but this fact does not by any means make the book less important to anyone who raises fish. The same laws of heredity which apply to humans and higher animals apply just as well to fish, oysters, plants, bacteria, and even viruses. Therefore, a reader interested in fish has only to use the word "fish" whenever any other animal is described and to substitute the names of various fish diseases for diseases of other animals.

All the examples cited by Dr. Hutt are equally important and interesting, but only a few examples are mentioned here.

Foulbrood is a very destructive bacterial disease of honeybees. In 3 years it was possible to obtain through selection colonies of bees in which the resistance was raised from 28 to 75 percent.

> Subsequent studies by Woodrow and Holst brought out the interesting fact that the apparent resistance of these colonies resulted chiefly from the highly efficient measures taken by their public-health officials to prevent the spread of foulbrood. Bees of the "resistant" colonies were more diligent than others in detecting the disease at early stages, in cleaning out infected cells, and in removing diseased brood before the causative bacteria reached the dangerous stage of infectious spores. By these measures, which, it should be recognized, differ little from those used by the medical health officers of other communities to control typhoid fever, the responsible officials in the "resistant" colonies protected their fellow bees from an epizootic catastrophe.

When an oyster disease first occurred on the shores of Prince Edward Island in 1915, the rate of mortality was more than 90 percent. By 1930 a resistant strain of oysters was noticed, and by 1940 the yield of oysters was higher than before the disease struck in 1915.

The white diarrhea or pullorum disease of chicks is one of the more destructive poultry diseases. Leghorns are more resistant to this disease than other breeds of chicken. The incubating chicken egg is cold-blooded just like a fish, "its temperature being no higher than that of the circumambient air." A chicken becomes warm-blooded the minute it hatches but takes about 10 days to attain a constant temperature (105° to 109° F.). It has been found that the temperatures of leghorn chicks rise more quickly than the temperatures of other breeds in the first 10 days after hatching, and that this inherent faster increase in body temperature is an important factor in resistance to pullorum disease.

Dr. Hutt's book is written in an easy manner and reads like a witty novel rather than like the scientific book that it is. Anyone with even a moderate interest in biology will find it difficult to put the book away before reading to the last page. It definitely will be an eye opener to anyone confronted with the problem of animal diseases. Fishery biologists or fish-hatchery managers will do well to find out for themselves why I recommend it so highly. Information obtained from this book is likely to pay greater dividends than we expect. I am sure that fishery workers will read it through and return to it often. Let us hope that it will soon inspire a similar book on the genetic control of fish diseases.

---S. F. SNIESZKO, Bureau of Sport Fisheries and Wildlife, Kearneysville, West Virginia.

Indigenous to only 2 lakes in Japan, the kokanee or land-locked form of the red salmon is so well liked in that country that "Hime-masu" (Hime = a lovely girl; masu = salmon or trout) has been established by transplants in some 20 lakes.

BLOCK-OFF NET FOR TAKING FISH-POPULATION SAMPLES

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AS PART OF A STATEWIDE FISHERY INVESTIGATION, fish populations were sampled extensively by rotenone poisoning. To obtain the samples, we found it necessary to surround the sample areas with some type of block-off net. The purpose of this report is to describe a block-off net which we found useful in the taking of fish-population samples.

The use of a block-off net has many advantages. It accurately delimits the sample area. It prevents fish, except very small individuals, from leaving or entering the treated area. It prevents fish which are selectively killed on the outside of the sample area (such as shad) from being included in the sample. From our observations we have learned that the inclusion of shad that are selectively killed on the periphery of the sample area can seriously bias the data. The block-off net prevents predaceous fish (such as gar and bass) which are attracted by the dying forage fish from being included in the sample.

The majority of the rotenone samples that we have taken were in 1-acre areas. Therefore, we have found a block-off net 280 yards long to be the most efficient size. A net 280 yards long surrounds a 1-acre area with four equal sides. If one side of the sample area happens to be the shore, the extra 70 yards of the net is placed on the shore. We have not attempted any rotenone sampling in water more than 20 feet deep, and therefore the net that we use is 20 feet deep.

FIGURE 1.--Block-off net used while taking rotenone samples of fish populations.

The materials needed to construct a nylon-webbing and a cotton-webbing block-off net and their approximate cost are shown in the table. As would be expected, a nylon block-off net would cost considerably more than the cotton block-off net. However, it is probable that the nylon net is less expensive in the long run when such items as its longer life expectancy and greater ease of handling are considered. We recommend the nylon net.

In constructing the net, the webbing is first hung on the bottom line (0.5-inch

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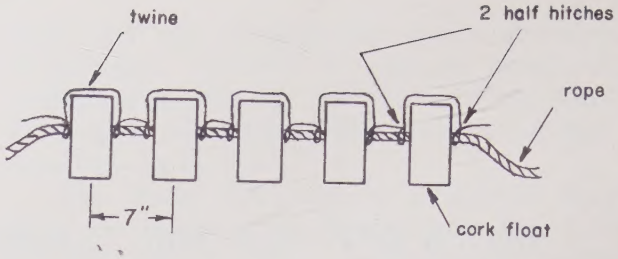
MATERIALS AND COST OF NYLON AND COTTON BLOCK-OFF NETS

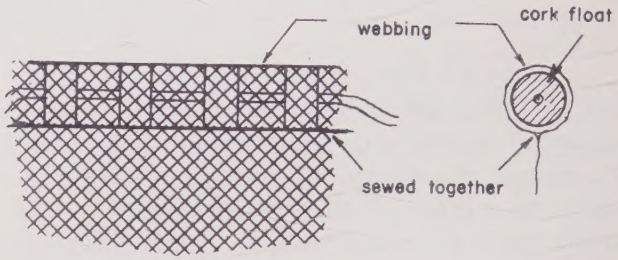
Materials	Approximate cost
Nylon block-off net	
280 yards of nylon webbing, 20 feet deep, 1 inch square mesh, No. 12 filament nylon---	$1,840
1.5 coils of 0.5-inch manila rope, steam-tarred, fishermen's lay (1,200 feet to the coil)----------	90
1,500 cork floats, 4.5 inches in diameter----------	225
27 pounds of No. 15 nylon filament twine (hanging twine)----	70
	$2,250
Cotton block-off net	
280 yards of cotton webbing, 20 feet deep, 1 inch square mesh, No. 9 medium twine, double selvage----------	$ 485
1.5 coils of 0.5-inch manila rope, steam-tarred, fishermen's lay (1,200 feet to the coil)----------	90
1,500 cork floats, 4.5 inches in diameter----------	225
22 pounds of No. 12 cotton medium twine (hanging twine)--	23
0.5 drum of net preservative----	35
	$ 858

manila rope) on a 1/3 basis, i.e., six meshes of webbing hung on the length of four meshes. We have not found it necessary to use any weights on the bottom line, but this must be wet before being used.

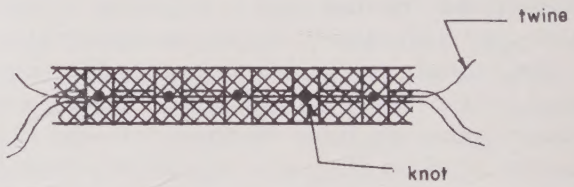
Corks are placed close together on the float line, and the netting is hung over the float line. This arrangement of the float line prevents waves from washing floating fish out of or into the sample area (figure 1), except when the water is extremely rough. Figure 2 shows the construction of the float line.



Step A. Cork floats are placed on 0.5-inch rope and fastened with twine.



Step B. Webbing is hung over the cork floats. Twelve inches of webbing is required to encompass floats. Top of webbing is sewed back to itself with twine 12 meshes from top.



Step C. Twine is laced through top of webbing on top side of floats and knotted to webbing every six meshes. Twine is hung tight in order to keep webbing from between floats.

FIGURE 2.--Construction of float line.

Observed in order to determine their threshhold for electrical stimulus, two electric eels held in an aquarium made no involuntary response unless the voltage applied was over 250 volts--or about 10 volts per inch of eel.

TO CONTRIBUTORS

Contributions for publication in THE PROGRESSIVE FISH-CULTURIST are always welcome. All contributions should be directed to: The Editor, THE PROGRESSIVE FISH-CULTURIST, Bureau of Sport Fisheries and Wildlife, Washington 25, D. C.

Manuscripts should be typewritten, double-spaced, on one side of white bond paper. Illustrations should be in the form of sharp, glossy, black-and-white photographs or drawings prepared with waterproof black India ink on heavy white paper or tracing cloth.

A short abstract should be submitted with each manuscript. When an article has appeared in an issue of THE PROGRESSIVE FISH-CULTURIST, the publication data will be added to the abstract and this will then be forwarded to Biological Abstracts and Sport Fishery Abstracts.

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